

**AN INVESTIGATION INTO FUELWOOD ENERGY CRISIS AND ITS
MITIGATION STRATEGIES IN MARAXWE VILLAGE, LIMPOPO
PROVINCE.**

BY

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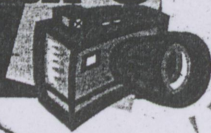


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THE FIRE OF LIFE!



Because many South Africans live in desperate conditions in our country, the ancient resource of fire is a source of energy for many. But for fire to exist, fuel must be gathered. This difficult task is mostly the responsibility of the women and children of our land.

Lebo Seopa of Grassmere squatter camp collects wood before sunset to keep her family warm.
Photo by Noko mashilo

Poor people in rural areas like Agnes Mathaba and of Mogoto in Zebediela, have no access to electricity. They are forced to collect firewood in order to make their families warm and for cooking.
Photo by Jerry Mokgwankgwa

These two Ndebele ladies, Nondumiso Mabasa and Pertunia Sithole, are heading home after collecting firewood.
Photo by Judas Hlongwane

Little Clarisa heads home after helping out with the hard and tedious chore of collecting firewood for the family. The long walk back is the difficult part as the load becomes heavy and difficult to manage.
Photo by Antoine de Ras

Johannah Mahlangu of Bronkhorstspuit photographed outside her colourfully-decorated house while collecting wood to prepare breakfast.
Photo by P Eland

In Kilpgat, electricity is a luxury. This woman carries wood from the veld.
Photo by Themba Maseko

Women play an important role in the collecting of wood. Here four ladies head home from fetching wood in the field.
Photo by P Eland

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ABSTRACT

Fuel wood energy is the energy that is extracted from wood materials this includes – branches, stems, twigs and stems. The energy harnessed in this source is used for different purposes in Maraxwe area this include: cooking, heating, warming, lighting, brick burning or hardening, pot making or pottery and other activities. Due to many activities attached to one and the same source, severity of effects on fuel wood resources increases.

The study therefore is undertaken to investigate into rural fuel wood energy crisis in Maraxwe village, and to come up with different alternative sources of energy. It will also alert people on their utilization, extraction, rate and depletion on fuel wood. Through this they will be aware and participate in ways to mitigate the problems.

The outcomes of the research will therefore clearly identify or describe the problem, assess factors that affect fuel wood energy and resources thus coming up with strategies to solve the problem sustainable. The crisis has caused many socio-economic as well as ecological problems in the local community and their environment.

According to the study the problem has-been identified and there is a need for solutions to mitigate the crisis. After interviewing local community members and representative leader a potential solution was derived at- namely the use of biogas was suggested as better alternative source of energy (capable of mitigating the crisis).

I, Ratshibvumo Thihanedzwi of the Student No: 11520922 hereby declare that the Bachelor of Environmental Management degree dissertation submitted by me at the University of Venda is my original work and has never been submitted by anyone else in the institution. By this I agree that it is the original work in design and analysis and the reference materials therein has been duly acknowledged.

Signature: Ratshibvumo Thihanedzwi.....

Date: 27.02.06.....

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CHAPTER 1: INTRODUCTION

1.1. BACKGROUND

All living creatures, from the smallest single-celled organism to most complex mammals, must create and consume energy to survive (Brown,1993).this is because energy is the ability to do work (Miller,1997). Human beings owe their dominant position on earth to their ability to exploit the natural sources of energy around them. Every aspect of human society, from the provision of heat and light and the construction of homes to the transportation of materials and industrial production, requires that human being tap energy contained in sunlight, wind, flowing water, and in natural occurring fuels (Brown, 1993).

The process of industrial revolution, population growth and increase agricultural practice has led to large demand of fuel wood energy and its removal, resulting to an imbalance between extraction and regeneration thus contributing to most forest and resource depletion (Hall *et al.*, 1995).

The rapid increase in problem of fuel wood extraction is because in most cases these resources are non-commercial or traditional fuel – are usually not bought or sold. Though presently they are marketed, they maybe gathered freely from local environment. Fuel wood energy has been used extensively for many years and are the fuels most closely associated with crises of energy for survival (Hall *et al.*, 1995).

When wood become scarce, people are forced to spend longer time and to go further to gather it, to switch to less favourable fuels such as agricultural residues, start buying fuels, when previously they gather them freely or adapt arrange of other responses to the problem of scarcity. Energy problems are undermining development strategies and jeopardizing the survival prospects of the poorest and most vulnerable sections of community in many parts of third world countries (Smith et al, 1988)

The word's poor face hidden energy crises of fuel wood availability which threatens their survival. Most of third world poorest people live rural areas where biomass fuels

are the main source of energy, used by all poor and rich alike, but it is the poor who are hit first and hardest by shortages of such fuels (Bale et al, 1993)

A fuel wood energy crisis is a result of different factors or trends, their interaction and serious implication for the future. These are: rising world's population, poverty and rising energy demand (Brown et al 1986). The situation is also happening at the study area that's why there is a need of study so to come up with some resolutions to save environment and people.

1.2 JUSTIFICATION

Fuel wood energy is the major source of energy in the third world countries basically in rural areas since time immemorial. Due to many activities that were undertaken using fuel wood, it led to their over utilization and over extraction as population grow and demands increases.

The situation also prevails at Maraxwe village wherein fuel wood has been overextracted in need of large agricultural space, construction and wood crafting materials and energy to use for cooking, warming and heating. This has results to a problem because fuel wood was just extracted without equity to its regeneration rate.

Energy as the ability to do work is the basic requirement in life of the whole world; if this energy is not utilized sustainably everyone will be endangered with energy depletion. As energy utilization is mostly associated with poverty, depleting fuel wood to solve the problem can be increasing the problem indirectly.

The research was undertaken with the aim to investigate much on the major problems that are being faced by fuel wood as a major source of energy. This will alert local communities on their strong relationship with environment so that they could develop care on environment as is their part of life. This is so because people ignore and neglect environment forgetting that is their basic source of life. The study was also done to come up with some measures to mitigate the energy problem and this will help local people on what good source of energy to use and in which way. Through this, resources will be managed sustainably.

1.3 PROBLEM STATEMENT OF THE RESEARCH

The study was undertaken in order to investigate the energy problems faced in Maraxwe village and to come up with strategies that will mitigate the problem faced. It was a short term research wherein the local communities were involved in data collection and literatures were reviewed. The process involved the identification of principal source of energy used, other local sources of energy used, to find out factors that cause fuel wood overextraction, socioeconomic effects of fuel wood overextraction; identify alternative sources of energy that can solve the problem in sustainable manner.

The findings of the research will help local people of Maraxwe village to know the importance of fuel wood as source of energy to life, know how to utilize them sustainably, and also develop ways that can conserve fuel wood as source of energy and conserve its energy. The document will also be made available to local people and local municipal to show them the environmental state .through this they can develop good ways to conserve resources and save the environment as a system.

1.4 OBJECTIVES

1.4.1 General Objective

To investigate a fuelwood energy crises and its mitigation strategies in Maraxwe Village.

1.4.2 Specific Objectives

- ❖ To identify current sources of energy being utilized in the study area.
- ❖ To identify the causes of wood collection/usage in the study area.
- ❖ The identification of the socio- economic and ecological effects of fuel wood collection/usage on the environment of Maraxwe Village.
- ❖ To identify alternative sources of energy to mitigate fuel wood energy problems and to assess their applicability in the study area.

1.5 REREARCH HYPOTHESIS

Several sources of energy are being utilised in the area with fuelwood as the principal one and there are also some socio-economic causes of wood usage. The rate of fuelwood extraction causes some effects on wood resources, ecology or environment itself and socio-economic life hence there is an urgent need to identify alternative sources of energy to mitigate the fuelwood crisis in the area.

1.6 RESEARCH DESIGN

A non-experimental design using a post-test method was used during the research. In this case there is experimental site only which is in Maraxwe village. The research has helped in assessing the major and other sources of energy being utilised in the area, causes of the problem, its effects and to come up with some measures to eradicate or mitigate the problem. The outcomes were used to prove the presence and severity of the problem.

1.6.1 Site Selection

The study area is in Maraxwe which is located at about 40 km from Thohoyandou under Thulamela Municipality in Limpopo Province.

1.6.2 Data Collection Methods

1.6.2.1 Primary data collection methods

a) Social survey

This is the data collection method which involves interviewing the people staying within the area of study. People say their views pertaining what is being asked informally by a researcher. People were interviewed to get the most source of energy being utilised in the area, the cause behind its utilisation, the effects that arise after the extraction and use ecologically and socio-economically, also to find out what other source of energy or alternative can be used to mitigate fuelwood crisis in the area.

b) Field Survey

Survey was undertaken in order to collect data about the situation in the study area. It has involved the identification of major sources and other sources utilised, causes and effects of over utilisation and helped in identifying alternative causes of energy that can mitigate the crisis.

1.6.2.2 Secondary data collection methods

1.7 DATA ANALYSIS AND PRESENTATION

Data was also collected through literature review wherein journals, books, newsletters, internet and other relevant documents were used to get the data concerning the research problem and its work.

Data was analysed both quantitatively and qualitatively.

1.6.2.3 Time schedule

The research was a short term, and was done with duration of a year.

according to which characteristics they possess.

1.6.3 Sampling size

to how much of a characteristic they possess.

Area was sampled randomly, 30 households out of 100 in the village were interviewed to collect the relevant data concerning the research work.

Data was presented differently using graphs, tables and charts.

1.7 DATA ANALYSIS AND PRESENTATION

1.7.1 Data Analysis

Data was analysed both quantitatively and qualitatively

Qualitative data analysis methodology – this is the measure that categorizes subjects according to which characteristics they possess

Quantitative data analysis methodology – measures that categorizes subjects according to how much of a characteristic they possess

1.7.2 Data Presentation

Data was presented differently using graphs, tables, and photos.

CHAPTER 2: LITERATURE REVIEW

2.1 INTRODUCTION

Since time immemorial biomass energy (mostly woodfuel) was and is still the basic fuel for about 3.2 millions of rural households, providing approximately 65% of their energy needs. But Third world populations do not use only these fuels, there are other fuels that are being used to fulfil the same activities done by fuelwood and do some extra once depending on source of energy. Although South Africa's program of electrification is reaching an increasing proportion of such households, fuelwood is expected to remain the dominant domestic energy source in rural areas for many years to come. Current consumption is estimated to be in excess of 8 million tonnes per annum (Miller, 1997).

2.2 NATURE AND SIGNIFICANT OF RURAL ENERGY PROBLEM

Rural energy problem has stricken almost all global rural households and this has brought a crisis that shows not to disappear from the earth (Eckholm et al 1997). African countries are the worst concerning this crises because their populations depend heavily and at about 90% on firewood, this include countries like Kenya, Gambia, Nepal, Ethiopia, South Africa, Zimbabwe and many more (Miller, 1997).

In many countries poverty has deadly contributed to the overextraction and overutilisation of biomass resources basically firewood. And in return it has also increased the poverty rate because of the impacts of fuelwood overextraction and or deforestation which has lead some areas infertile, other degraded and in some cases causing desertification and malnutrition (Feuerstein, 1997).

Rural energy problem is now seen as a major contributor towards environmental problems that are on burning issues presently including deforestation, disturbance of ecological functions and loss of biodiversity in South Africa, Africa and globally (Nico, 1997).

2.3 MAJOR SOURCES OF ENERGY THAT ARE BEING UTILIZED IN THE AREA

Since time immemorial wood was and is still the basic fuel for about 3.2 millions of rural households, providing approximately 65% of their energy needs. But Third world populations do not use only these fuels, there are other fuels that are being used to fulfil the same needs that fuelwood can supply and do some extras depending on source of energy.

There are three broad categories of energy sources that are used in rural areas

2.3.1 Non-commercial or Traditional fuels

These fuels are non-commodified, that is, they are not bought or sold – may be gathered freely from the local environment these are biomass fuels including: wood, Charcoal, and crop and animal residues. The traditional fuels have been used since the beginning of man's life. They are basically the original fuels to be discovered by man and have been suitable to do the tasks man try and need to do and are also favoured because they are renewable sources of energy (Sossan, 1998).

Although South Africa's program of electrification is reaching an increasing proportion of such households, fuelwood is expected to remain the dominant domestic energy source in rural areas for many years to come. Current consumption is estimated to be in excess of 8 million tonnes per annum (Huntley, Sunter 1989). This is also manifested in other countries like Zambia, Zimbabwe, Mozambique, Ethiopia, Kenya, and Nigeria. Fuelwood is the most traditional source of energy which is basically used in rural areas of developing countries including Maraxwe.

Plate 1 as attached in Annexure; A shows some of the stacked fuelwood that is used for cooking and warming in one of the household at Maraxwe village.

2.3.2 Commercial or Modern fuels

These are the fuels that have been developed and put into market during the period of industrialization after 1800's. these fuels are mostly attached with monetary terms, that is, they are sold or not freely available for anyone. This includes oil in its different forms including kerosene or paraffin, gas and coal, electricity (Brown, 1993).

These fuels have a commercial value and are frequently imported from areas where they are present and or abundant to areas without or with shortages for market and use value. Most of the commercial fuels have been used widely in comparatively recent years and has been associated with the most crises of energy for development globally. The crises of commercial fuels are affecting both poor and rich nations directly and indirectly (Denis, 1993).

In most nations presently commercial fuels (mostly fuel) are at high demand than before because development is spreading everywhere and at a fast rate. Countries like, *inter alia* United States of America, Zambia and South Africa their high demands also causes price shifts in oil price because is not abundant. Recently oil prices has rise very high in such a way that all other fuels were pushed to increase in price. This also results in problem to the world: energy crises and poverty being increasing because of great expenditure (FAO, 2004).

2.4 CAUSES OF FUEL WOOD COLLECTION AND UTILIZATION

2.4.1 Cooking and Lighting

The human population globally is rapidly increasing and due to this food has been grown in large quantities. Cooking has become essential than before when population was still very low. It is said that the amount of energy which is demanded for cooking purposes is generally not intrinsically defined, but largely dependent on the efficiency of the method and processes employed that is, this will include food that are being cooked and the time they take to get ready. In the developing countries it is far harder to burn firewood efficiently mostly because cooking is done outside houses and in open spaces where most energy is lost by wind blowing. As population has grown rapidly most families in rural areas have many members, therefore more food will be expected thus, lot of wood is required to serve this purpose this also demand lot of fuelwood causing resource depletion (Bale 1988, Herman 1993).

Plate no: 2 shows utilisation of fuelwood for cooking purpose and it can also warm houses on cold days.

Household fires also has effect on children because most of them help their mothers in lighting and maintaining the fires during which smoke is inhaled and which is likely to be affected by breathing and could lung problems.

2.4.2 Heating Houses

Different seasons tend to transpire in different areas countries at different times. These seasons tend to vary with their. Temperatures in many areas during winter season are very low and cold, because of this there is a need to warm the bodies and houses. In developed countries people commonly use electric heaters and air conditioners for warming. Most of the people in rural areas do not have access to the heating technologies like electricity and coal heaters this will force them to go to the bush to collect fuelwood that will be used to make fire to heat houses and warm people. Heating houses has also contributed a lot in fuelwood overextraction and its

crises because during cold seasons is overutilised in a fast rate not balancing with its regeneration rate (Peter, 1993).

2.4.3 Brick Burning and Pottery

Previously houses were constructed by mud bricks and sometimes with wood materials. As population increases and lot of houses were to be built so people do away with the mud and start to use strong bricks. Strong bricks make the house to be very hard and to last longer than mud that's why people prefer them. For bricks to be very strong they need to be burned first and this require fuelwood energy. In many countries government also promote the use of burnt bricks for both rural and urban communities than cement ones. This has been adopted because people thought the costs are cheaper compared to cement ones mostly in Kilimanjaro, Nigeria, Gambia, Zambia and South Africa. This has resulted in energy crises around many countries because the burning of bricks require lot of wood and wet wood is overutilised than dry ones to keep the fire for a long time making bricks to be stronger (World Bank, 1996).

2.4.4 Currying Tobacco

Tobacco is another product which is very competitive in the market presently and because of this people have started cultivating it in large scale to develop their economy as well as their life. During the processing tobacco need to be curried before it became a final consumable product and this requires energy. Many companies and countries prefer wood fuel than other expensive sources of energy in currying tobacco besides the price of other energies traditionally it is believed that tobacco will be best if it has been processed using fire than other sources of energy like electricity. So this perception has lead to a great overutilisation of wood resources exacerbating its crises. Like in Tanzania Tabora region tobacco cultivation has caused a great forest clearing for both growing and currying which has amounted to approximately 22% forest loss per year. It is said that in many cases 1 hectare of harvested tobacco needs 1 hector of woodland to cure (FAO, 2004).

In Zambia Oxfam field fuelwood energy crises has transpired since the tobacco farms moved into the neighbourhoods and start using firewood for currying tobacco.

2.4.5 Population Expansion and Poverty

Human population explosion and poverty are seen as the most critical environmental problems globally but critically in southern Africa. As population increases rapacious consumption pattern continue, nature's limits manifest and natural ecosystems are not having an opportunity to renew themselves mostly vegetation. According (Miller, 1996) in the book *People and the Environment* population of southern Africa is currently growing at an average of 2.3% per annum with blacks contributing highly by 2.8% growth followed by coloureds then whites.

In South Africa roughly 8 million tons of wood is burnt as domestic fuel and is mostly from sources that cannot regenerate equally extracted amount which result in fuelwood energy crises. Many people of about 60% in South Africa can not afford to use electricity even though they have it because of poverty, so this results in greater utilisation of fuel wood.

In Kenya Kakemega district which contains a population densities of up to 1000 persons per km² the pressure on fuels uses of wood are acute sometimes wood are extracted and sold this issue has resulted in overextraction of wood and increasing energy crises .

Globally poverty is seen as the cause behind fuelwood overutilisation. This is because most of the poor villages are unable to access and afford environmental friendly and convenient fuels. Countries like Zambia, Gambia, Mozambique, Zimbabwe, Ethiopia, and Nepal are also poor in such a way that they prefer fuel wood as their major source of energy like South African rural areas (World Bank, 1996).

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2.5 IMPACTS AND OR EFFECTS OF FUEL WOOD EXTRACTION, PRODUCTION AND CONSUMPTION

Though fuel wood face problems itself, its extraction convention and utilization in various forms is recognised as one of the major contributors to environmental degradation at global level as well as the local level and this continuous effect also affects other variables. This is both ecologically and socioeconomically

2.5.1 Ecological Impacts

When energy is produced and consumed there are many impacts that can be felt ecologically. Amongst others the following are the most common recognised ones that if not tackled or dealt with the environment will vanish thus no life will exist.

2.5.1.1 Deforestation

Deforestation is a permanent destruction of indigenous forests and woodlands wherein less or no trees are left to survive in a certain environment. This effect usually can change the state and visibility and functioning of a particular environment (Miller, 1993 and Nico, 1997)

Every minute of the day around the clock, around the world more than 90 acres of forest or woodlands are cut down for a total of more than 40 million a year for the sake of energy. This is happening in both developed and developing countries. Currently 12 million hectares of forests are being cleared annually and this is happening mostly in moist forests and open woodlands of the tropics (Nico, 1997) an estimate proportion of total energy consumption provided by wood vary from (amongst others) 74% for Kenya, 94% Tanzania, 65% South Africa 60% in Malawi this has devastated large areas of native forests and bush land. Zambian copperbelt for example a total of 391,400ha of natural woodland was deforested for household and industrial woodfuel to around 1984 leading to 51% forest loss. In Malawi 3.6% forest is cleared every year and Kenya 1.5% which is said to lose most of indigenous forest by 60% (Kenedy, 1998)

Deforestation always carries with it serious consequences for the planet (Cherington, 1992).

For instance in 1988 400 people were killed in Thailand because of the floods that were exacerbated by deforestation around the area which was caused by fuelwood over extraction.

Many areas around South Africa, Nigeria, Namibia, Zambia, Zimbabwe, Mozambique, Nepal and Botswana have been severely cleared for energy purposes. In the year 2000 South Africa was severely stricken by floods and the effects were very critical this was because most of the areas have been cleared and left with soil exposed nothing (Rooke, 1993).

Plate 3 shows the rate of deforestation for agriculture and fuelwood collection purpose

2.5.1.2 Loss of biodiversity

Trees provide diets, bridge hunger periods, control floods, droughts, famine and work as medicine. Their removals will hinder all this together with the species survival. Forests provide home for a huge number of different species animals and plants because they have different habitats. So when they are cleared totally the biodiversity will also be lost thus disturbing the ecological functioning of nature (Nico, 1997).

Current estimates are that hundreds species become extinct annually world wide as a results of deforestation and clearance of vegetation for energy purposes amongst others (Davidson, 1992).

Plate no: 4 shows the effect of deforestation and as population expands

2.5.1.3 Soil erosion

This is the removal of fertile top soil by forces of either wind or water (Rooke,1993) with any removal one tree specie forces of erosion are exacerbated soil erosion has

resulted to a greater land loss of about 20million hectares per year causing a decrease in output of natural rain fed crops by 20% globally. Soil erosion has been regarded as a far more serious threat than depletion of energy resources this is because humanity cannot survive without topsoil even if they have energy (Klugman, 1993).

In Swaziland removal of vegetation for energy generation has created gullies, and removed lots of soils thus hindering the crop production. And most farm in Limpopo province like in Thohoyandou Maraxwe village the schemes no longer produce as they use to before because of the effect of soil erosion and these force farmers to use plant nutrients or fertilizers.

2.5.1.4 Desertification

If the whole trees are felled in the area, not only this will change them to be a non renewable resource but will also live the area bare, expose the topsoil and is likely to be leached and removed by heavy rains. All these conditions will never favour species development and an area can be developed into a semi desert or desert this is very common in tropical areas like Limpopo province which is next to tropic of Capricorn. A desert will also be created. Man will not live or supported without topsoil though it can live without oil, so that soil erosion is a far more serious threat than depletion of energy sources (Davidson *et al.*, 1992).

2.5.1.5 Loss of nutrients

On more intensive scale, felling of trees for fuelwood causes the loss of plant cover and exposure of land surface to intense seasonal rains, soil erosion, decreased infiltration and this causes the loss of nutrients and fertility leading to an overall decline in productivity (Kennedy, 1998). Removal of vegetation in Swaziland have created gullies and or dongas erode top fertile soil leading to loss of nutrients and fertility in the area (Klugman, 1991)

2.5.1.6 Air pollution

Fuelwood energy has contributed to green house gas emissions and local air pollution due to submergence of forests or their degradation for fuelwood use and its combustion.

(Ravindranath, 1995 and Ocampo, 2005). Forests and or trees help a lot in stabilising the global climate through the absorption of carbon dioxide, so without them air pollution increases and global warming risks increases. This is also manifested in sub-Saharan Africa (Agarwal, 1986). When wood is being burned some particulates and gases like CO, CO₂ are released and this causes air pollution in the local area and can by chance affect other neighbouring areas. This pollution can cause diseases to people within the area mostly children and old aged ones (Nico, 1997)

2.5.1.7 Change in micro climate

Large scale clearance of vegetation has resulted to an increase level of carbon dioxide CO₂ in the earth this is because when trees are cut less remains thus resulting in less carbon dioxide absorbed. In many cases this result in increase of temperature in local area. This condition is also contributing to green house emission effect globally which is causing global warming (Hall, 1995). Loss of vegetation can also affect the hydrological cycle of an area making less rain to fall and the area's climate can change to the hot one like in Namibia (Miller, 1997 and Nico 1997).

2.5.2 Socio economic impacts of energy production and utilisation

2.5.2.1 Marginalisation of women

Fuelwood crises have many responses, fuelwood collection will increase in distance, time, who collects, frequency of collection, change in bundle weight and type of fuel collected; in this case effects are greatly felt by women. Women will spend most of their times on energy matters and this drove them away from health and social care issues in their families thus marginalising them (Agarwal, 1997). Most of these women end up illiterate and they never get employment thus increasing the rate of poverty in the area. This is manifested in countries such South Africa, Rural China, Kenya and Nigeria (Dasgupta, 1994)

2.5.2.2 Health and Nutritional cost

Fuelwood combustion releases some pollutants and this causes indoor pollution. Carbon dioxide that is released usually interferes with normal inhalation of oxygen in the body thus resulting in health hazards particularly for women during cooking time. Severely children who are still at the back of their moms are at greater risk because the smoke produced by combustion can affect them easily (Davidson et al, 1992).

Example: acute respiratory illness in Gambia 1992 affect more children under five years and greatly who were still in their moms back but those who are not carried on back during cooking have been found with less risk. Similarly to their mothers, non smoking women in India and Papua guinea who have cooked by biomass stove for many years were found to exhibit a higher prevalence of chronic disease than who have lower levels of exposure to cooking smoke. And most of them die sooner than male smokers (FAO, 2000).

Women will mostly spend their time to and fro bushes collecting fuelwood and left with less time to care for themselves. On top of this shortage of fuelwood will force women to cook food that get ready soon spending less fuel, this will result in nutritional cost because of different disease this s will include protein energy malnutrition (PEM), Iron deficiency, anaemia, iodine deficiency disorder and lack of vitamins. These results is medical costs for the whole family (Feuerstein, 1997)

2.5.2.3 Underdevelopment

Time spent in gathering fuelwood represents a lost opportunity for schooling and productive employment .example: Kenya women spend 20-24 hours per week collecting fuelwood. and this leave them with less time to care for themselves and this are people in developing countries and some of them live in less than a dollar<\$1 per day (Agarwal, 1997).

2.6 ALTERNATIVE SOURCES OF ENERGY TO MITIGATE THE CRISES AND THEIR APPLICATION AT MARAXWE VLLAGE

Alternative sources of energy are the renewable energy sources that cannot be depleted

The demand for wood and charcoal has been so high in most of the tropical countries of the world in such a way that the forests has been pushed back, woodlands destroyed, savannas changed into open grasslands. This has been derived by massive deforestation which has increased the wood shortage and many environmental consequences.

Human society can slow down environmental damage and buy time for the development of alternative energies that are clean and plentiful. Renewable Energy Technologies

(RETs) can provide good quality alternatives, and indeed can be more reliable in providing electricity than grid extension (Gregory et al, 1997). Presently there are significant numbers of economically attractive applications for renewable energy technologies but they will suit regions differently being influenced by several factors that influence a community in choosing a type of energy which are the following:

(a) Occurrence – the availability and non availability of an energy source in a particular area. Example areas that are always cloudy like Khakhu village in Limpopo province, South Africa can not choose solar energy as their alternative because it won't be effective and Russian areas because is a snow area.

(b) Transferability – this is portability of a source of energy, whether it can be moved from one place to another. Energy content, bulkiness and infrastructures required to transfer the energy source will determine its use in other areas

(c) Flexibility - whether an energy source can be used for many tasks. People will prefer the sources that are of multi use.

(d) Reliability – the availability of a source of energy to be available at any time in need. Its presence need not be interfered

(e) Efficiency- low energy content tends to be insufficient or inadequate in times of high demand and they are unlikely to satisfy the demand. So they will be less preferred.

(f) Storability – energy sources that can be stored for use at later date will be most preferred than the less storable ones.

(g) Cleanliness and convenience – dirty sources and less convenient ones are less favoured than clean and most convenient ones

(h) Safety and impacts – energy sources that have low risk level of danger and accidents are the best chosen than unsafe ones which have more impacts on environment

(I) Price – cheap energy sources will be preferred by many people than expensive ones

(Chapman, 1989)

There are several alternative sources that have been recognized but though some are not new as they were being used previously in one way or the other.

2.6.1 Biomass Energy

This is the energy which is derived from the organic matter, this includes wood, plant or agricultural residues, household, municipal and industrial wastes (Hall, 1995)

In biomass energy generation wood is the most common in both developing and industrial countries for production and processing of heat, electricity, and potentially for other fuels such as combustible gases and liquid

2.6.2 Solar Energy

Solar energy involves the use of sunlight to generate electricity. Solar has been used since time immemorial only that methods of harnessing it were a bit different from the once used presently. There are different methodologies in which solar can be harnessed.

2.6.2.1 Photovoltaic cells

This involves a direct conversion of sunlight into electricity using solar cells which are made of silicon crystals. When sunlight is absorbed in semi conducting materials, the solar energy knocks electrons loose from their atoms, allowing the electrons to flow through the material to produce electricity. The whole process above is called photovoltaic effect. This energy can do many things like lighting in houses, signal buoys, and power remote radio, television, and telephone relay stations for communication industry. This technology has the most universal application for providing least cost electricity to rural areas of developing countries and others developed areas which need to reduce cost of electricity (Odum, 1997)

Example - a village on Coconut Island between Australia and New Guinea has been using this for more than five years and it's really effective. South Africa's most rural areas has adopted this for years and is really working, areas like Limpopo province in Tshifudi, Tshififi, Muswodi, Messina, Thengwe and the University is also cutting cost through the use of solar panels to heat water.

2.6.2.2 Concentrating solar power

This uses several methods like parabolic trough, solar tower and dish engine systems. These power system uses sun as heat source to activates the generator that produces electricity.

2.6.2.3 Solar hot water

Naturally water can be heated by sunlight. This way can also be used to heat water for uses in buildings and swimming pools. This could be through the use of solar collector and storage tank with antifreeze solution to be heated finally heated water will be actively pumped or passively by gravity through storage tank to a place of use.

2.6.2.4 Solar process heat and heating and cooling

Commercial, industrial and residential areas need ventilated air to maintain indoor air quality

2.6.2.5 Passive solar heating and day lighting

This is a direct gain of sunlight for use to heat buildings. This can be achieved by building large north facing windows, building sunspaces and trombe walls.

Solar together with other sources alternatives promise to offer a competitive and environmentally safe replacement for fossil and nuclear fuels.

2.6.3 Hydroelectric Power

Flowing water creates energy that can be captured and turned into electricity, this is called hydropower. This energy can be generated from vast amounts of water that covers the earth's surface, from dams, rapids, waterfalls and small canals and also tidal power or ocean water. Water from this source will flow through a turbine, spinning it while activating a generator to produce electricity. The largest scale renewable energy sources development are associated with water power and it show to be of high quality and generates most work when it can amplify other energy flows.

The use of hydropower dates back from 1882 at Fox River near Appleton, Wisconsin. Industrialised nations have already exploited most of their good hydropower sites including Asia, Latin America, and Middle East. Venezuela also has the world's biggest dam Guri dam, Brazil Itaipu Dam, Cariba Dam, Cabara Basa, Aswan dam in Egypt and many more globally.

2.6.4 Wind Energy

Sun heat the earth unevenly which create area of low and high pressure that causes steam of air to flow or more horizontally from one place to another, this is called

wind. Energy that is derived from the wind is dependent on its speed or velocity, the higher the speed the more is the energy that can be tapped from the air mass (Howard, 199).

Human beings have been using wind energy for a long time in sailing boats and windmills example: wind cools our body and dries our laundry, it air conditioned areas, propel vessels, lift water, and generate electricity at dispersed locations

2.6.5 Geothermal Energy

This is the energy which is derived from the earth's natural underground heat sources (WCED, 1987). Recently many technologies has been developed to take advantage of this type of energy and its uses has been increasing at more than 15% per year in both industrial and developing countries. This energy can be generated in different ways which can help for its use and its conversion to electricity

- Geothermal electricity production – this is the generation of electricity from the earth's heat
- Geothermal direct use producing heat directly from hot water within the earth
- geothermal heat pumps using the shallow ground to cool and heat buildings as cooking heating ,cooling, lighting amongst others are the major uses of energy geothermal energy can provide these functions with ease as it cost less

2.6.6 Biogas Energy

Biogas is produced by anaerobic fermentation of biomass such as dung, municipal wastes and crop residues (Parker, 2001). Diesel engines can be converted to burn biogas and generate electricity households and landfill sites help a lot by being storage for wastes to process energy. The plants can be family sized though, in this case, their output is usually more suitable for cooking than generating electricity and the plants can be designed to fit the mini input available or maximum gas consumed

required. Community plants are more economical but the maintenance and distribution of costs and benefits are difficult to organise but once done they are done benefits are more. Biogas energy is mostly utilised in areas like India and China and Tanzania which have the largest scale of all around Africa (Fulford, 1998).

There are many advantages to biogas technology for people in rural areas of developing countries. Because the plant can digest materials that are readily available on small farms, such as animal dung and crop wastes, produces clean high grade fuel gas and gives a residue that is a good fertilisers. It is also more convenient than fuelwood, dried dung and kerosene, doesn't dirty pots, irritate eyes (Parker, 2001). India has reported about 200,000 biogas reported by 1984, Asian countries, Korea 30,000 by 1979 and Brazil 7,530 by 1985. According to the unpublished masters research: the effectiveness of biogas in solving rural energy problems has clearly demonstrated its effectiveness over other energy sources in solving rural energy problems (James, 2003). Against the above biogas is proposed as the best alternative in Marenxwe village.

3.1 Geology and Topography

The geology rock essential in Marenxwe is volcanic which was formed due to cooling of molten magma under and above ground. This that are found in the study area are sandy soil and clay soil.

3.4 Climate

Following climate conditions of the study area has been considered:

3.4.1 Average rainfall

Marenxwe experiences average rainfall and it is evenly high from November to February. The average area rainfall ranges from 400mm to very wet around 500mm.

Chapter 3: Ecological Setting of the Study Area

Information concerning the ecological setting of the study area was collected through reconnaissance surveys in order for the researcher to be familiarized with the study area.

3.1 Location

Maraxwe village is situated in the Northern region of Limpopo province under the jurisdiction of the Thulamela municipality. The village is found at approximately 35 km from Thohoyandou town. The geographically profile of the area is as follows:

3.2 Physiography

Maraxwe area is comprised of undulating gentle and steep slopes and it is a mountainous area.

3.3 Geology and Pedology

The parent rock material in Maraxwe is sandstone which was formed due to erosion of sedimentary rocks upslope and alluvium. Soils that are found in the study area are sandy soil and clay soil.

3.4 Climate

Following climatic conditions of the study area has been considered:

3.4.1 Average rainfall

Maraxwe experiences summer rainfall which is mostly high from November to February. The average area rainfall ranges from 400mm if very low to around 800mm

3.4.2 Temperature

The temperature varies greatly between summer and winter. During summer temperature ranges between 18 degree Celsius and 38 Celsius, where as in winter it can range between 10 degree Celsius and 26 degree Celsius.

3.4.3 Wind

Maraxwe village doesn't experience strong winds though there are some winds that prevail from west to east mostly during winter and some other days in a year.

3.5 Hydrology of the area

The area has got a nearby perennial river which is Mutale River. Maraxwe village is also bordered by some seasonal rivulets and or streams which are: Thorothoro and Dzhivhuwo which only flows during rainy seasons. There is also a reservoir and a furrow which supplies water in the area for different purposes this includes domestic uses and irrigation purposes.

3.6 Biodiversity

Maraxwe village has many species this include both fauna and flora with many life forms.

The most common trees in the area are listed below.

Table 3.6.1: biodiversity of the area

Scientific names	Local names
<i>Terminalia prunioides</i>	Mutwari
<i>Pterocarpus angonsis</i>	Mutondo
<i>Dichrostachys cinerea(Africana)</i>	Murenzhe

<i>Acacia ataxacantha</i>	Muluwa
<i>Grewia mycrthyrasa</i>	Mupfuka
<i>Zanthoxylum leprieuril</i>	Munungu
<i>Erythrina latissima</i>	Muvhale
<i>Acacia borleae</i>	Muunga
<i>Sclerocarya birrea(caffra)</i>	Mufula
<i>Androstachys johnson</i>	Musimbiri
<i>Pteleopsis myrtifolia</i>	Mwanda
<i>Xylopiia parriflora</i>	Muvhula vhusiku
<i>Galpini</i>	Mugwiti

Animal species include few impalas, wild pig, baboons, monkeys, squirrels, hare, Reptiles include snakes, gecko, and chameleon

3.7 Land Uses

Different land uses are found in Maraxwe village.

3.7.1 Agriculture

It constitutes a large part in the study area because it occupies about 2½ kilometres in width of Maraxwe and 2 kilometres in length. It is composed of almost equal plots of cultivation lands allocated to each family and others do have orchards up the mountains and down towards Mutale river. In this area cash crops and other vegetables are cultivated for both subsistence and commercial purposes. An estimated percentage of 50% is occupied by agriculture

Plate 5 Representation of agriculture as the major landuse in Maraxwe village

3.7.2 Residential area

Residential area in Maraxwe takes a part of an area but less than that of agriculture at about 40%. It takes a clustered form with huts, small, medium and big houses. The road is a gravel one.

3.7.3 Commercial

There are no industrial sites in the area but there are some few shops, tuck shops, butcheries, bottle store, churches school but no clinic, this constitute a less percentage of about 5% of an area. There is also a commercial plantation of boom trees at the foot of the mountain.

The problem of fuelwood crises is greatly affected by land use in the area this is because all factors that are exacerbating the problem are based there:

- The increase in population growth has lead to large demand of space for living
 - Larger space for agriculture in order to feed the whole population
- And all these has lead to clearance of vegetation loosing animals and plant species thus on other way exacerbating fuelwood crises in the area

Chapter 4: Materials and Methods

4.1 Research Design

The research was done using a non experimental strategy wherein experimental site will be used or assessed without control site.

4.2 Types of Data Collected and their Importance

Different data were collected in the study area to further this research. This includes:

4.2.1 Data on sources of energy being utilised

Information concerning the sources of energy being used in the area of study has been gathered. This information shows to be very crucial in this research because sources need to be compared and see which source is being overutilised and what is making it to be very competitive than others. Ten families have been sampled randomly. Stands were just calculated and to each count the 15th household was assessed.

4.2.2. Data on causes of fuelwood over-extraction

There are some reasons and purposes why people are overutilising wood resources. Some of the reasons are subsistence whereas others are economically based. The data on these causes need to be extracted in order to see the cause of the problem which this however can lead to the identification of the solution to the problem. 20 families in this case have been identified randomly for sampling purpose. They were selected based on their economical status and interviewed. This shows to be a good sampling method as poor, moderate and rich will have different reasons for utilising fuelwood as their source of energy.

4.2.3 Data on impact of fuelwood collection

The overextraction of fuelwood resources has many impacts locally and globally varying from ecological, social to economical impacts. On this research data on impacts were very crucial and therefore has been prioritised in collection. Impacts are the ones which stimulate researchers to investigate into deep to prevent the problem from expanding and also save the environment and quality of social life.

Socioeconomic impacts data on this was collected by random sampling in 20 families based on their economical status with the reason that poor and rich won't be affected similarly by the crises of fuelwood.

Ecological impacts were not deeply assessed as there was no control site, so field survey has been undertaken to identify environmental impacts and some photo were taken on areas that really manifest the severity of the problem.

4.2.4 Data on alternative sources of energy

Alternative sources of energy helps I solving the energy crises of the world similarly this can apply to the area being researched. Data concerning this issue is therefore very crucial to obtain as this will help on coming up with better strategy (ies) that can solve fuelwood crises in Maraxwe village. 20 families were sampled randomly following their economic status and social status including number of members in that household. This strategy was followed like this because as a researcher I believe that different people groups will suggest and prefer different alternatives pertaining their status and ability to access to that source.

4.3 Data Collection Technique

Different data collection techniques were used to further the research. Two important methods were used throughout the whole work.

4.3.1 Social Survey

Under social survey local people were interviewed to get exactly what is transpiring at the area concerning the types of energy which are being used. All the houses at Maraxwe village were numbered accordingly and out of those numbers 30 houses were sampled using statistical table. Minimum sample sizes of the houses were determined statistically because 30 households were determined out of 100 households. The sampled households are the ones which have been interviewed. In the process of interview different key questions and or aspects were asked from local people to get the results.

4.3.1.1 Sources of energy being utilised in the area

The following types of questions were asked in the interviews:

- a) What type of sources do you use?
- b) How much of that source do you use?
- c) Where do you get it from i.e. locality?

The crucial reason behind the above questionnaires was to acquire information on the sources of energy which local people are using.

4.3.1.2 Causes of fuelwood utilisation and or extraction

The following questions were asked in the interviews:

- a) Why are you using the specific energy source?
- b) Where do you get the particular energy source?

This was an important data to acquire because it really shows the reason behind fuelwood utilisation either its locality or accessibility.

4.3.1.3 Alternative sources to mitigate the energy crisis

To acquire the information on the alternative sources of energy that can be used to mitigate energy crisis in Maraxwe village, the below questions were asked or acquired from local people.

- a) What other source do you think can be used to replace fuelwood?
- b) Do you think that source can work effectively?
- c) What other measures and means do you think they can be applied to solve the problem?

4.3.2 Ecological Survey

The survey was undertaken on the site to personally observe and collect some of the relevant data. The area has been surveyed to find and or identify sources of energy which people are using, the causes of such utilisation and the impacts which are faced by the local and surrounding communities. The area was also surveyed to see if there is availability, accessibility and affordability of alternative sources of energy. This is so because crisis can be caused by unavailability and unaffordability of the energy sources. As a researcher there is a need to undergo field survey to prove and validate your data, also to gather some data which local households or interviewees would have missed. In the process of field survey people were also interviewed and asked on some aspects based on the specific objectives.

4.3.2.1 Sources of energy being utilised in the study area

Besides interviews on sampled households, the community leaders like Chief and businessman were also interviewed to get their views on what source of energy is used basically, the reason behind that, the effects it bring later and the alternative sources that can be used to solve the problem.

4.3.2.2. Effects of fuelwood overextraction and its crisis

The following questions were asked to get the required data on the effects of fuelwood crisis::

- a) What are the worst consequences of fuelwood crisis you encounter?
- b) How do they affect your life?

This information was crucial in order to identify the effects of fuelwood energy crisis and their severity so to come up with the alternative ways to mitigate the problem in the area.

As a researcher I've also check the area walking around to see some effects that are being brought around by fuelwood crisis. Baseline data was also used to find out other problems that were not there before the crisis.

Ecological effects were not measured and or assessed but one can clearly see them. This includes effects like deforestation, overgrazing, soil erosion and loss of biodiversity.

CHAPTER 5: RESULTS AND DISCUSSION

5.1 RESULTS AND INTERPRETATION

5.1.1 Data on sources of energy being utilised in the study area

Table 5.1.1: the sources of energy being used in the study area: fiel work 2005

Number of households using different sources of energy out of 30 sampled					
Energy resource	Fuelwood	Electricity	Gasoline	Solar	Gas
Number of respondents	30	15	7	5	1
Percentage	93%	50%	23%	17%	3%

Interpretation: Table 5.1.1 and graph 5.1.2 represents the percentage use of different energy source by residents of Maraxwe village. Wherein Fuelwood energy constituted the greatest percentage at about 93% this indicates that Fuelwood is principally used in the area and this is mostly for cooking, heating and warming then followed by Electricity with 50% which is mostly used for lighting and for other appliances like radios and televisions, Gasoline with 23% and this is mostly used for lighting and cooking, Solar at 17% which people use for lighting and operating radios and the source which shows not to be famous and not commonly used is Gas with 3% which is used for cooking.

5.1.2 Data on causes of utilisation of energy sources

Table 5.1.2 household energy use percentage (Source: fieldwork 2005)



Number of household using energy for different purpose out of 30 sampled					
Uses	Cooking	Warming and lighting	Brick burning	Tobacco burning	Total respondents
No of households	30	28	20	5	30
Percentage	100%	93%	67%	17%	100%

Interpretation: Table 5.1.2 is the representation of the causes of energy utilisation activities that are contributing to fuelwood crisis. According to the survey undertaken the basic greater cause behind the use of fuelwood is cooking which is represented by approximately 100% followed by warming and lighting activities which is 93%, then brick burning by 67% and lastly tobacco currying at 17%.

5.2 DISCUSSION

5.2.1 Sources of energy being utilised in the study area

According to the research that have been undertaken with the data collected in relation to the problem it has been found that fuelwood is the principal source of energy being utilised in Maraxwe village. This source is basically used for cooking, heating and warming. The source that follows but which actually doesn't compete with is electricity which is mostly used for lighting and in other appliances like radios and televisions.

5.2.2 Causes of fuelwood extraction and crisis

The identified most cause of wood extraction and utilisation in Maraxwe is poverty which leads to lack of access to electricity. Most people have shown that they cannot afford to pay the electricity for cooking rather the little that they could afford is for lighting. Fuelwood continues to be the most dominant used source of energy in most rural areas particularly for cooking, heating, warming, brick burning and tobacco currying and it usually accounts for about 70-80% of energy being utilised in most global rural areas. (<http://www.worldwideenergy.org/wecgeis/publications/reports/rural/exec:summary.asp>).

Most of the rural area people still have bad attitude towards new and conventional source of energy even though they are renewable sources, they still see fuelwood as the safe and best source of energy to utilise (Chapman, 1989).

5.2.3 Effects of fuelwood crisis

The investigation identified that the major problem and effects of fuelwood crisis is marginalisation of women and their underdevelopment in an area. This happens because women spend most of their times going to and fro the bush and forests collecting fuelwood, this results in less time to take care of themselves, their health, future and their family life (WHO, 1992).

Health and nutritional costs are also some of the outcomes that are manifested when there is a fuelwood crisis. These results in some diseases like kwashiorkor and protein deficiency mostly in elders and children in household members. This happens because less nutritional fast food will be preferred as there will be lack of firewood

<http://www.wvic.com/hydro-facts.htm> Ecological effects have also been identified in the area of study. Deforestation has been found to be the most effect that has threatened the village and this has been proven through the baseline data which was collected. Soil erosion, land degradation are manifested in the area and this has also affected the biodiversity of the area changing the microclimate in the village to be of hot conditions. Clearance of vegetation has also contributed to loss of nutrients in the area through excessive erosions and this is manifested during cultivation time wherein people are increasing the use of artificial fertilisers than before whilst the production is decreasing. Energy as the fundamental need to human survival and its prospects for human has really contributed too many environmental problems that have arisen presently like fuelwood crises (Elliot, 1997).

5.2.4 Alternative sources of energy which can be used to mitigate the problem

Through the interviews which have been done it have been diagnosed that people prefer biogas as a better alternative source of energy that can replace fuelwood, followed by solar, electricity, hydropower and finally wind energy. But other people has suggested an efficient use of fuelwood in hidden areas and when necessary.

Globally biogas has tried to solve the fuelwood energy crises better than some alternatives. Example: in India and China most households are using biogas energy that electricity and this ha been constructed for community in some towns (Parker, 2001).

CHAPTER 6: SUMMARY, CONCLUSION AND RECOMMENDATIONS

This chapter include a summary of the whole undertaken research and information on how data was collected and analysed research hypotheses will also be analysed to see if they can be confirmed and supported or rejected. Research work will be concluded and recommendations for the whole work and further research will also be done.

6.1 Summary

The research was undertaken with the aim to investigate into fuelwood energy crisis in Maraxwe village and was undertaken within a short period time of a year.

Different literatures has been reviewed in order to identify different factors contributing to fuelwood energy overextraction and overutilisation, its effects and to find out alternative sources which can be used to replace fuelwood and mitigate the crisis.

The ecological setting of the study area was also described to make it easier for the reader to know the area and to can identify it.

Data were colleted differently, their importances were also mentioned and the way how they were analysed and presented were also shown.

From the data collected it has been found that fuelwood is the principal source of energy which is being utilised in Maraxwe village. This source contributes a larger percentage of about 98% than other sources and is mostly used for cooking, heating and warming purpose.

Reduction and or scarcity of fuelwood in the area have brought some effects and impacts to the local community. This includes marginalisation of women,

underdevelopment, and the use of less nutritional food which have lead to some diseases like protein deficiencies.

Ecological impacts are also manifested in the area this include deforestation, loss of biodiversity, soil erosion, land degradation, loss of nutrients in the soil and change in the micro climate in the area and all this were brought about by fuelwood crisis.

During the research process and interviews with local people it has been identified that fuelwood energy crisis can be solved in Maraxwe village. Some alternative sources of energy were identified and recommended as the ones which can solve the problem.

Above all biogas has been recommended as the best to solve the crises then followed by solar, wind, water and the effective use of fuelwood.

6.2 Conclusion

The research under the investigation of fuelwood energy crisis was done in Maraxwe village, was undertaken to identify the energy crisis and come up with a mitigation strategy.

6.3 Recommendations

6.3.1 Alternative sources of energy

The problem was identified in area of study and dealt with; the aim of undertaking the project was to come up with a solution to solve the problem. Finally some strategies were suggested to solve the fuelwood energy crisis in Maraxwe.

6.3.1.1 Biogas

This is the energy which is produced by anaerobic fermentation of biomass such as dung, municipal wastes and crop residues. Diesel engines can be used to burn biogas and generate electricity or to operate a dual-fuel (biogas-diesel) mode.

The technical options available vary from simply sinking pipes to extract gas from existing landfills to large-scale digester. Agricultural and forestry residues available in rural areas of developing countries provide necessary input for this technology (Fulford, 1998).

Example: In India biogas programmes have been carried out using animal wastes. These plants can be designed to fit the mini input available or maximum gas consumption required (Parker, 2001)

6.3.1.2 Solar

The sun is the primary source for most if not all forms of energy that are found on earth. This energy has most advantages because it is clean, abundant in most of the areas and renewable source (Brown, 1993). Solar energy have the great potential to benefits the nation and can diversify energy supply, reduce the rate of import to external and most expensive fuels and its production can limit a lot the green house gas emissions and can create jobs during installation process (Gregory etal,1997).

Maraxwe village is situated in Limpopo province which is in the equator, this province is very hot and receive the high intensity enough heat to generate electricity for use. This energy has been found to be another source which can work effectively in Maraxwe village. Concentrating solar power, photovoltaic, solar heating, solar lighting and passive systems can all be applied and work effectively in Maraxwe as some passive methods and photovoltaic methods are already in use.

6.3.1.3 Wind

Wind energy uses wind to generate electricity and this method has been used since time immemorial. This method is regarded as new and an alternative

because it is now used to generate electricity. Wind energy is considered as green power technology because it has only minor impacts on the environment, produce no air pollutants (Hall, 1995). Because of this wind energy can also take part in solving fuelwood energy crisis around the world including Maraxwe village. Windmills, local mini grids and national grids can be used to supply energy in the community and at lower costs. Maraxwe village is not that windy but this energy can be used as supplement to biogas and solar energy in other cases.

6.3.1.4 Hydropower

Hydropower is a clean energy which is generated from water. Sea, river underground water and dams can all work together in production of this energy. Recently this energy is providing about 97% of all electricity generated by renewable energies. (<http://www.wvic.com/hydro-facts.htm>).

Maraxwe village is bordered by Mutale River on its South and for this reason water is available for generating electricity. This way can not be so effective because the river is far and it can be costly to transport the electricity. For the protection of fuelwood energy and to avoid its crisis water energy can be another option following biogas, solar and hydropower.

6.3.1.5 Geothermal

This energy is generated from the earth's heat, and can be used directly and indirectly. Geothermal can be used to generate small scale electricity for use in local areas and for use in industries. This energy produces low pollutants gases and is renewable as long as the source is available (<http://www.eere.energy.gov/RE/geothermal.html>).

This energy is not recommended in Maraxwe village as the area doesn't have the geothermal energy sources. But other places in Limpopo province like Tshipise area can use this source as the area does have the source. And this can be very effective in solving energy crisis and limiting the costs of energy.

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Plate No1: Cooking and washing in domestic uses of fuel wood

ANNEXURE A

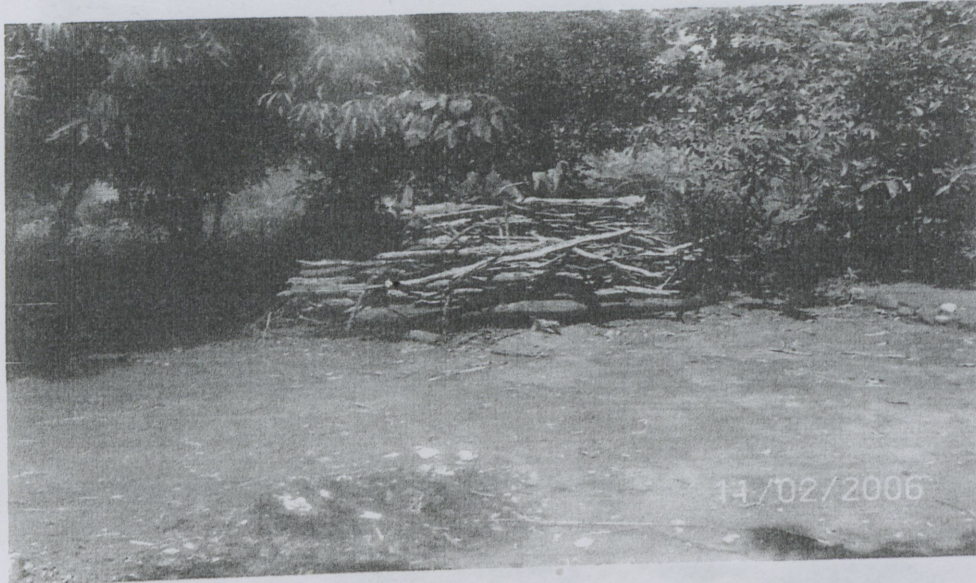


Plate No1 fuel wood stack for domestic purposes



UNIVERSITY OF VENDA
LIBRARY

Plate No2 cooking and warming as domestic uses of fuel wood



Plate No 3 deforestation for fuel wood collection and agricultural purposes



Plate no 4 Deforestation by population pressure and population growth.



Plate No 5 Agriculture as major land use in Maraxwe