Journal of Sustainable Development in Africa (Volume 13, No.5, 2011)
ISSN: 1520-5509
Clarion University of Pennsylvania, Clarion, Pennsylvania

HOUSEHOLD ENERGY DEMAND: WOODFUEL CONSUMPTION AND PERI-URBAN DEFORESTATION IN THE CITY OF MASVINGO (ZIMBABWE)

Jemitias Mapira and Ackim Munthali
Great Zimbabwe University

ABSTRACT

Household energy demand in Zimbabwean urban centres has led to massive deforestation on the outskirts of these settlements as residents search for wood fuel, in the wake of prevailing power cuts and load shedding strategies. This study examines the city of Masvingo, which is currently facing this problem. It is based on surveys that were conducted between September 2007 and October 2008. Four methods were used in the collection of data namely: literature review, questionnaire interviews, field surveys and measurements. The study shows that rapid rates of deforestation are currently underway on the outskirts of Rujeko C Extension, one of the low-income residential areas. They range from 11% to 85% with an average of 38% in the surveyed areas. This has led to desertification and land degradation in general, which are threats to bio-diversity and the natural environment. Several solutions are proposed for the achievement of sustainable development at city level. They include: the development of thermal, hydro-electricity, solar and wind energy sources as well as the development of energy-saving meters.

Keywords: Woodfuel Consumption, Deforestation, Masvingo City

INTRODUCTION

In recent years, Zimbabwean urban settlements have been facing energy-supply problems for industrial, commercial, transport and domestic needs (Kunaka, 1991). This scenario has led to an increasing demand for such energy sources as fuels and electricity. In 1986 for example, the country spent Z$248.2 Million on electricity and fuel imports (Munowenyu, 1996). The main sources of energy in the country during that year included: coal (38%), wood fuel (32%), hydroelectric power (13%), petroleum fuels (12%), bagasse (4%) and other minor types such as solar energy, ethanol and benzol (2%).

Zimbabwe's heavy dependence on non-renewable sources of energy such as: coal, wood fuel and petroleum is a cause for concern especially from an environmental protection viewpoint (Whitlow, 1988). While the mining of coal has led to land degradation in a few places, in many parts of the country, natural woodlands have disappeared in the wake of deforestation that has been triggered by the widespread demand for wood fuel, cultivable land and timber for construction purposes (Magadza, 1992).

Several studies have been conducted in Zimbabwe in order to show the negative impact of human activities on natural ecosystems. The most outstanding one is that of Richard Whitlow, which was conducted during the first decade of the country's independence from Britain in 1980 (Child and Heath, 1992). As a national survey on land degradation, the study identifies the main areas that have been affected and the main causes of the problem (Whitlow, 1988). According

to the study, some of the areas that have experienced intense deforestation and degradation are communal lands and peri-urban areas of major cities such as Harare and Chitungwiza.

During the 1990s, more studies were conducted on the same theme. They included those of Moyo, S. et al (1991), Magadza (1992) and Lopes (1996). The studies examine problems of energy demand, wood fuel consumption and deforestation in the light of the country's goals of sustainable development. According to Magadza, at national level, wood fuel consumption around 1992 accounted for 23% of the total energy consumption. This led to massive deforestation, which was a threat to the country's goals of sustainable development. During this period, Zimbabwe was losing about 70 000 hectares of woodland due to the demand for cultivable land and wood fuel for household consumption. As a result, 30% of the country was experiencing acute shortages of forest products (Magadza, 1992).

Lopes (1996), identifies Zimbabwe's four main goals that were formulated during the first decade of independence. They included:

a) *The Equity Objective* aimed at ensuring long-term security of supply as well as developing strategies of redistribution to neglected communal areas and fuel pricing concessions,
b) *The Growth Objective* intended to ensure that supply met demand in industry and commercial agriculture while stimulating economic development in communal areas,
c) *The Energy- Self- Sufficiency Objective* aimed at reducing dependence on imported fuels in order to save foreign currency, and
d) *Wood fuel Supply Sustainability Objective* geared at achieving environmental sustainability. This would be attained through the development of indigenous energy resources such as coal, hydroelectric power and wood fuel while promoting renewable energy sources such as wind and solar energy.

In order for national objectives to be achieved, there is need for effective legislation that is free from contradictions. During the first decade after independence, Zimbabwe's environmental protection laws were highly fragmented as various government ministries had their own legislations (Mapira and Mungwini, 2005). Examples of ministries, which had such legislations included: Ministries of Agriculture, Environment and Tourism, Health and Mines. Some of the common legislations that were associated with different ministries included: The Natural Resources Act, The Parks and Wildlife Act, The Water Act and the Forest Act (Magadza, 1992). Due to the fragmentation problem, it was difficult to monitor and implement the laws as the ministries often operated at cross-purposes.

However, this problem was resolved during the new millennium with the promulgation of the Environmental Management Act (Chapter 20:27), which came into operation in 2002 and harmonized the various pieces of legislation that had operated in isolation leading to unnecessary ministerial conflicts (Mapira and Mungwini, 2005). The Act also led to the establishment of an Environmental Management Agency (EMA) whose basic aims include (among other things):

a) Regulating and monitoring the management and utilisation of ecologically fragile ecosystems
b) Developing and implementing incentives for the protection of the environment,
c) Making model by-laws to establish measures for the management of the environment within the jurisdiction of the local authorities,

d) Undertaking any strategies deemed necessary for the protection or management of the environment where it appears to be under threat, and

e) Regulating and monitoring access by any person to the biological and genetic resources of the country in general.

Although EMA has been in operation for half a decade, its impact at local level is yet to be realized. Thus the aim of this study is to achieve four goals, which include:

a) Examining energy demand and use in the residential areas of Masvingo City,

b) Determining their impacts on wood fuel consumption patterns in these areas,

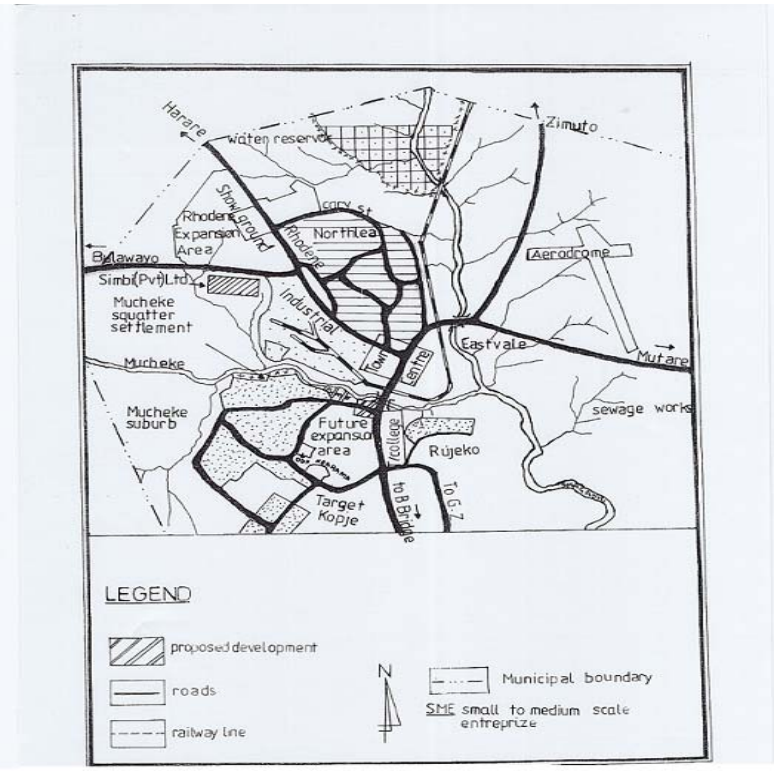
c) Assessing their impacts on peri-urban deforestation, and

d) Suggesting solutions for the problems discussed in the paper.

STUDY AREA AND RESEARCH METHODS

The city of Masvingo is located in the south east of Zimbabwe and is the administrative capital of Masvingo, one of the country's ten provinces. It has four broad types of residential areas, which include: high, medium and low-density areas as well as agricultural smallholdings. High-density areas accommodate low-income citizens. They include: Mucheke, Rujeko and Runyararo. Mucheke is the oldest of the three, having been established in 1950 as the only residential area for blacks (Scott, 1991). Rujeko and Runyararo are products of the city's post-independence housing programmes. They were established in 1985 and 1990, respectively. Over the years, Rujeko has developed in three phases namely: Rujeko A, B and C. The latter extension is not yet connected to electricity since most houses are still under construction. For this reason, the area largely depends on wood fuel for energy.

There are only two medium density residential areas in the city, namely: Eastvale and Target Kopje. Both of them are connected to electricity. The only low-density area is Rhodene, which is located in the northern part of the city along the Harare road. The city is also characterised by agricultural smallholdings, which are found on the outskirts. Examples include: Morningside and Clipsham. This study is based on information that was collected from five residential areas of the city between September 2007 and October 2008. The areas included: Rujeko, Mucheke, Runyararo, Morningside and the City (Centre Map 1).



Map 1: Masvingo City's main residential Areas

Four methods were employed in the collection of data, namely: literature review, questionnaire interviews, field surveys and measurements. Literature review involved a survey of literature on issues pertaining to problems of energy supply and their impacts on land degradation especially in urban areas of Zimbabwe. Various sources of information were consulted including: books, journals, city master plans and annual reports. Questionnaire interviews were conducted in the five residential areas mentioned previously (Mucheke, Rujeko, Runyararo, Morningside and the City Centre). They targeted some 52 randomly selected households, who were interviewed on issues of energy demand and use, wood fuel consumption and deforestation on the periphery of the city (Figure1). Data derived from their responses were analysed, tabulated and interpreted.

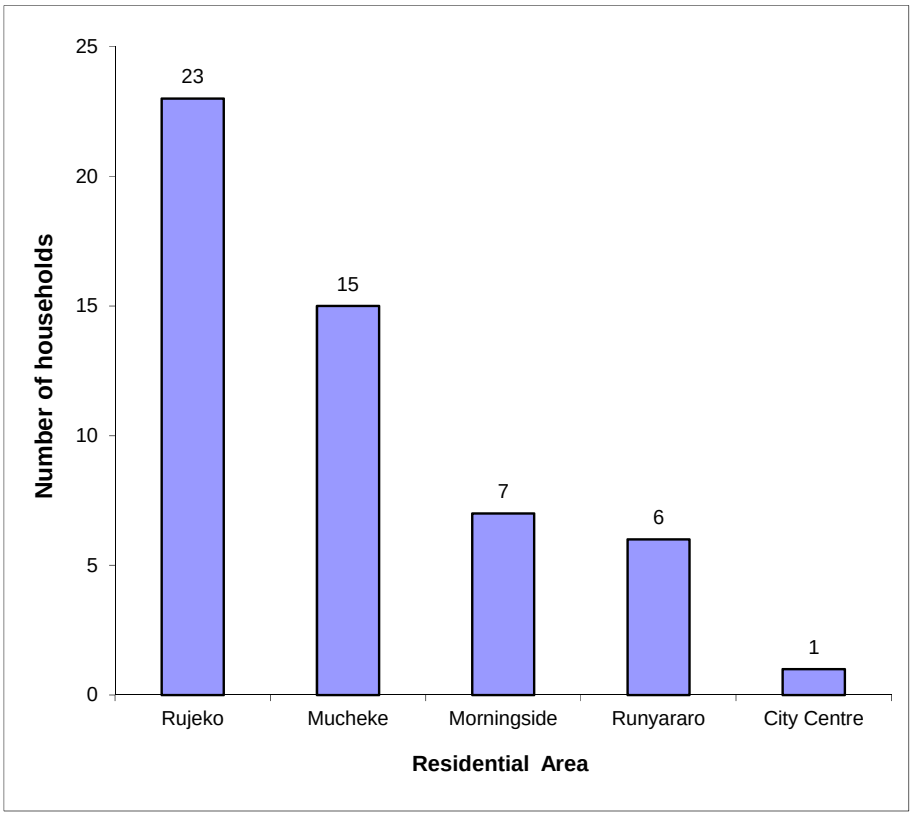


Figure1: Distribution of Responding Households

Field surveys were conducted on the outskirts of the city between Rujeko C Extension and Morningside (commonly referred to as the Shagashi Woodland) where processes of deforestation and desertification are currently underway. They involved the collection of empirical data on issues such as: rates of deforestation, species diversity and re-growth in the study area. The area covers a total of about 700 hectares (7 square km). It is flanked by Rujeko C Extension in the north-west, Morningside in the south and the Teacher's College in the east. While most of the area under study is located on the western bank of the Shagashi River, the rest is on the eastern bank. Before field surveys and measurements were made, the area was divided into squares or quadrates measuring 20m by 20m each. Some ten quadrates were randomly selected for intensive studies. They were drawn from the area of *partial deforestation* where desertification processes are currently underway (Figure 3).

RESULTS AND DISCUSSION

During the last national population census in 2002, Masvingo City had 69 993 inhabitants (CSO, 2002). However, more recent municipal reports estimate the population at 72 836 (City of Masvingo: Housing and Community Services Records Office, 2005). These people were accommodated in 9016 housing units comprising: Rujeko (3204), Mucheke (2323), Runyararo (2284), Target Kopje (71), Eastvale (183), Rhodene (812), Morningside (98) and Clipsham (41). Figure 2 provides a summary of this information in percentages.

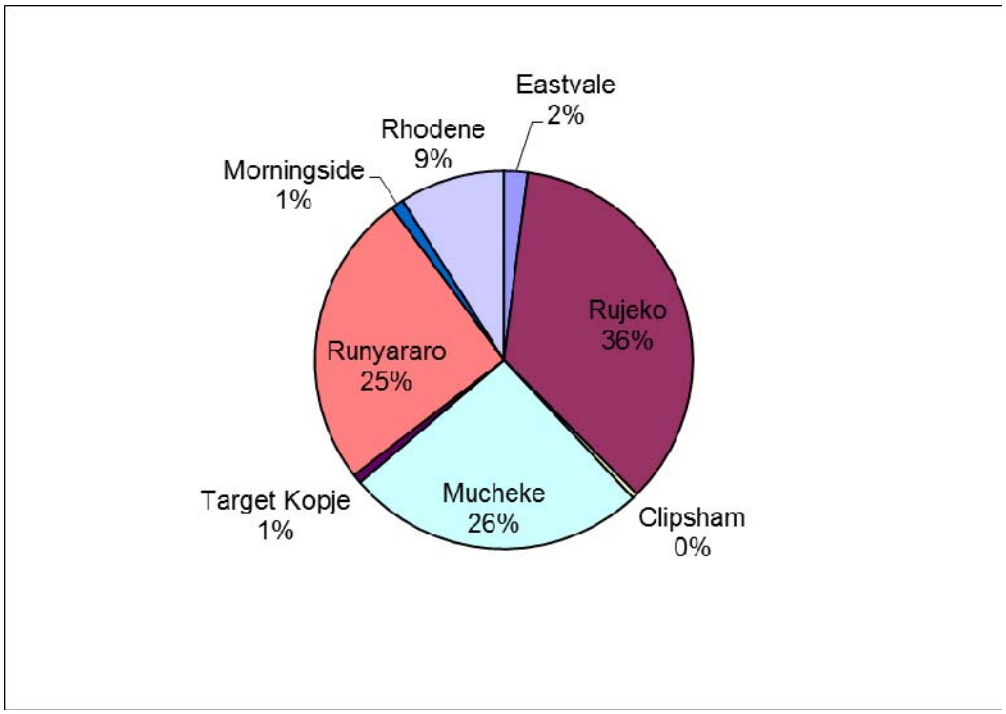


Figure 2: The Total Housing Stock in the City.

Over the years, the city has experienced phenomenal population growth through the combined processes of rural-urban migration and natural increase (Scott, 1991). This, in turn, has increased demand for energy in all residential areas. The most important sources of energy in the city in terms of frequency of use include: wood fuel (30%), candles (24%), electricity (24%), paraffin (13%) and others (9%). The latter category includes a variety of energy sources such as: solar power, torch batteries, generators, gas, diesel, cow dung and jelly (Table 1). It is pertinent to note that in terms of frequency of use, wood fuel tops the list followed by candles and electricity, paraffin and other sources, respectively. Since the bulk of residents rely on wood fuel, this has serious implications for the immediate environment, which they have subjected to deforestation and desertification over the years in order to meet their household energy needs.

Table 1: Sources of energy frequently used in residential areas of the city (in %)

Area	**Wood fuel**	**Candles**	**Electricity**	**Paraffin**	**Others**
Rujeko	13	11	9	7	4
Mucheke	8	8	7	4	2.5
Morningside	4	3	4	0.6	2.5
Runyararo	4	1	3	0.6	0
City Centre	1	1	1	0.6	0
Total	**30**	**24**	**24**	**13**	**9**

Source: Field Survey

Although most housing units are connected to electricity (Table 2), frequent power cuts due to load shedding in recent years mean that residents have to rely on alternative sources of energy, which are non-renewable and have negative impacts on the environment.

Table 2: Households that are connected to electricity

Area	Connected Households	Households not Connected	Percentage (%) Connected
Rujeko	19	4	83
Mucheke	13	2	87
Morningside	7	0	100
Runyararo	5	1	83
City Centre	1	0	100
Totals	**45**	**7**	**87**

Source: Field Survey

Sources of Wood fuel in the City

Households in the city of Masvingo obtain wood fuel in different ways. The bulk of them purchase it from vendors who are located in different parts of the city. For example, in Rujeko, the vendors operate at the shopping centre while in Mucheke some of them are found at the main bus terminus. In Morningside, most of them operate from their places of residence. They regularly sneak into the surrounding farms, where they cut down trees, dry the wood and then sell it to their customers. Distances travelled on foot into the farms range from 2km to 15 km (Table 3). However, in extreme cases, wood fuel is ferried by motorized vehicles from distances of over 40 km as in the case of Morgenster Mountains, Gutu and Rufaro Mission Farms.

Some vendors offer door-to-door delivery services to their regular customers. While some customers buy wood fuel on credit and pay the vendors during month-ends when they have received salaries from their jobs, others buy the wood only when they have cash to spare. Some households cannot afford the wood fuel that is sold by vendors. Instead, they procure it on their own through poaching excursions in the municipal farms that surround the city. A good example is the Shagashi Woodland, which is located between Rujeko C Extension and Morningside Plots. Over the years, this area has experienced intense deforestation due to the activities of wood fuel poachers in the city.

Table 3: Sources of Wood fuel for Rujeko Residents

Sources of Wood fuel	Distances in km
Rujeko Shopping Centre	0-0.5
Individual Vendors	0-0.8
Shagashi River Woodland	2-3
Morningside Plots	3-6
Four Brigade Plantations	5-8
Municipal Farm	10
Nhambure Farm	15
Newgate Lodge Farm	15
Morgenster Mountains	30-50
Gutu Farms	40-60
Rufaro Mission Farms	80

Source: Field Survey

Wood fuel Consumption Patterns and Deforestation on the outskirts of the City

Results from questionnaire surveys show that most households in the city consume between one and ten bundles of wood fuel per month. Each bundle ranges in weight from 15 to 20 kgs and comprises about ten pieces of dry wood, which average two metres in length and up to ten centimetres in diameter. Consumption levels therefore range from 15 kgs (one bundle) to about 200 kgs (10 bundles) per month depending on the size of the household. In general, large households (with ten or more members) consume more wood fuel than smaller ones (one to three members) especially in low-income residential areas where power cuts are more frequent and there are fewer alternative sources of energy. In the case of Rujeko C Extension, which is not yet connected to electricity, the dependence on wood fuel is remarkably high, as households solely depend on it.

The most popular tree species that are consumed as fuel in the city include: Musasa (Brachystegia spiciformis), Munhondo (Julbernardia globiflora), Mubondo (Combretum Zeyheri), Mupangara (Dichrostachys cinerea), Mupfuti (Brachystegia Boemii), Muunze/Muuzhe (Brachystegia Glauscens) and Mutara (Gardenia Volknsii) (Table 4). They burn well without producing much smoke (Drummond, 1981). However, wood fuel poachers have to transport them from distant areas due to their increasing scarcity in the nearby woodlands. Their scarcity in the vicinity has also forced some poachers to resort to the indiscriminate cutting down of unfavourable species such as: Muunga (Acacia Karoo), Muora (Albizia Amara), Muchecheni (Ziziphus Muchronata and Mususu (Terminalia Stenostachya) resulting in intensive land degradation on the outskirts of the city.

In general, two patterns of deforestation have emerged on the city's outskirts namely: selective and non-selective (or indiscriminate). Selective deforestation occurs far away from the city especially beyond 2km. Poachers target those trees that are suitable for wood fuel while the less favourable species are generally spared, which gives them a survival advantage over favoured species. Non-selective deforestation occurs close to the city mainly due to competition among the large numbers of poachers who are involved. Virtually all woody species are targeted, leading to the total clearance of the surrounding woodlands.

Table 4: Wood fuel Tree Species frequently consumed in the city of Masvingo

Shona Name	Common Name	Botanical Name	Popularity Levels in Figures	Popularity Ranking
Musasa	Msasa	Brachystegia Spiciformis	49	1
Munhondo	Mnondo	Julbernardia Globiflora	48	2
Mubondo or Mupembere	Bush Willow	Combretum Zeyheri	46	3
Mupangara	Sickle Bush	Dichrostachys Cinerea	38	4
Mupfuti	Prince of Wales feathers	Brachystegia Boemii	37	5
Muunze	Mountain Acacia	Brachystegia Glaucescens	37	5
Mutara	Common Gardenia	Gardenia Volknsii	37	5
Muunga	Sweet Thorn	Acacia Karoo	21	8
Muora	Bitter Albizia	Albizia Amara	17	9
Muchecheni	Buffalo thorn	Zizi phus mucronata	13	10
Mususu	Silver Terminalia	Terminalia stenostachya	10	11

Note: Names of different tree species were obtained from Drummond (1981)

Although Zimbabwe is a major producer of coal in the SADC region, Masvingo residents have not yet adopted the product as a source of energy. One of the reasons is that the city has traditionally depended solely on hydroelectric power from the national grid (Munowenyu, 1996). The lack of a thermal power plant in the city has meant that, for much of its history, coal has never been delivered there. However, in 2004 a new development occurred, which led to the introduction of coal supplies in the city (Shonhai, 2007). This was the establishment of the SIMBI Pvt. Ltd Iron Ore Processing Plant, some 5 km along the Bulawayo/ Mashava Highway. In order to sustain its daily operations, the plant ferries coal from Chisumbanje Mine, some 75 km from Chiredzi Town. It sells the surplus to individual companies such as: Gaths Mine (Mashava) and surrounding institutions including: Victoria Primary School, Gokomere, Mukaro, Lundi and Silveira Mission Schools (Shonhai, 2007 and Mapira, 2008).

In order for individual households to use coal as a source of energy for cooking and heating, they should be assured of regular supplies of the product at affordable prices. To date, SIMBI (Pvt Ltd) does not sell its surplus coal to individual households. As a result, residents largely depend on their traditional sources of energy such as: wood fuel, candles and electricity. In general, the main reasons for the continued use of wood fuel among the city's residents include:

a) The lack of affordable alternative sources of energy,

b) Frequent electric power cuts due to current load shedding strategies. This has made electricity an unreliable source of energy in most residential areas,

c) Wood fuel is the only viable form of energy as coal has not yet been adopted at the household level,

d) Wood fuel is easy to use and is cheaper than gas and paraffin,

e) Individuals can also collect wood on their own from the city's outskirts even though the practice is illegal and therefore punishable by local authorities,

f) Some residential areas such as Rujeko C Extension are not yet connected to electricity. Hence, they have no choice apart from resorting to the use of wood fuel.

Although the majority of households use wood fuel as their main source of energy, some do not. A number of reasons account for such cases. They include:

a) During power cuts, some residents use alternative energy sources such as paraffin, gas and jelly stoves for cooking and candles and solar energy for lighting.

b) Some households have generators, which they use in the event of power failures. However, these are very few as Table 2 has shown,

c) Wood fuel is quite expensive and it is only used in the event of power cuts, which are quite rare in such areas as: Rhodene, Morningside, Clipsham and the City Centre.

Wood fuel Poaching and Land Degradation

Deforestation on the outskirts of Rujeko C Extension dates back to the establishment of Rujeko Suburb in 1985. Over the years, the surrounding woodland has been heavily denuded of its natural vegetation and now comprises three distinct parts (Figure 3). By far the largest of them is that of *total deforestation* (60%). Areas of *partial deforestation* (30%) and those of *no deforestation* (10%) follow. While areas of total deforestation have virtually lost all their woody species and have been reduced to grass lands, those of partial deforestation are still undergoing deforestation. Although they have lost much of their original tree vegetation, a few patches or islands still remain in some places. Areas of no deforestation are still in their natural state since wood poachers have not yet invaded them. However, such areas are rapidly disappearing as the pie chart shows. Cases of re-growth or regeneration are visible in the affected areas. However, wood poachers cut down the new shoots as soon as they are large enough to be turned into wood fuel. That is why, in the long run, former woodlands degenerate into grasslands as in the case of areas of total deforestation.

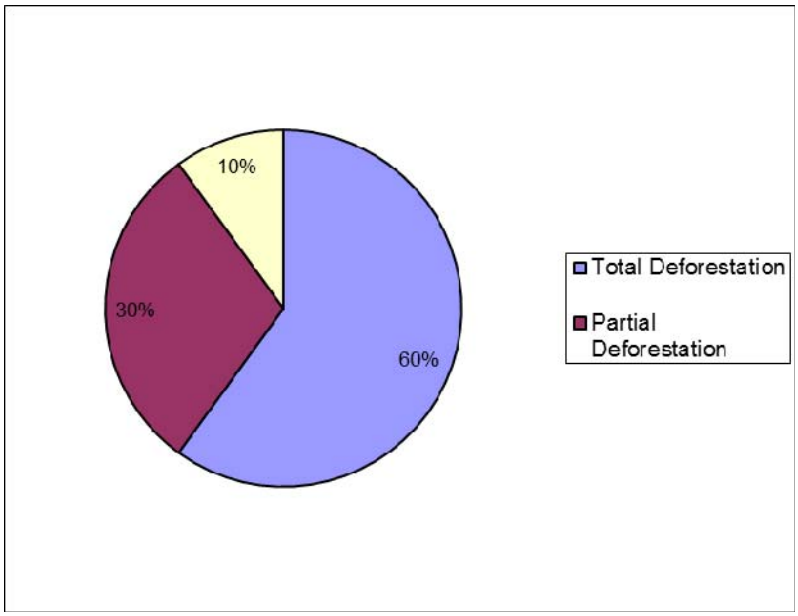


Figure 3: Stages of Deforestation on the Outskirts of Rujeko C Extension

Rates of deforestation in the surveyed areas are shown by the numbers of stumps compared to those of trees that are still standing (Table 5). For example, Quadrates 9 (2), 7 (4), 5 (5), 3 (6) and 4 (6) have the lowest rates while 2 (17), 1 (11), 6 (12), 10 (21), 7 (4) and 4 (6) have the highest. The rate of deforestation is also expressed in percentages in each quadrate. It ranges from 11% in the ninth quadrate to 85% in the second one. However, the majority of quadrates have rates of deforestation that lie below 50%, with three (1, 2 and 6) exceeding that figure. On average, the whole area has experienced a deforestation rate of 38% even though cases of re-growth or regeneration are notable in some places. It is significant to note that most trees that are still standing are quite young and not suitable for wood fuel. This is evidenced by the small average diameter (10cm) compared to that of trees, which have been cut down and now remain only as stumps (24cm) dotted on the landscape.

Table 5: Deforestation Rates on the Outskirts of Rujeko C Extension.

Quadrant Number	Number of Stumps	Diameter of Stumps in cm	Number of Standing Trees	Diameter of Trees in cm	Dominant Species	% Deforestation
1	11	37	7	4	Acacia Karoo	61
2	17	26	3	4	Albizia Amara	85
3	6	25	14	6	Acacia Karoo	30
4	6	25	9	3	Acacia Karoo	40
5	5	17	18	4	Terminalia Stenostachya	22
6	12	19	8	33	Acacia Karoo	60
7	4	28	6	32	Acacia Karoo	40
8	6	19	40	6	Acacia Karoo	13
9	2	14	17	6	Acacia Karoo	11
10	21	33	23	4	Acacia Karoo	48
Average	**9**	**24**	**15**	**10**	**Acacia Karoo**	**38**

Source: Field Survey

As mentioned previously, although the dominant tree species in the study area is Acacia Karoo (Muunga), which is not suitable for wood fuel; this has not saved it from wood fuel poachers, whose demand for energy is so severe that they engage in indiscriminate instead of selective deforestation. This has resulted in desertification on the outskirts of the suburb as mentioned previously. During the dry season, areas that have lost their tree vegetation are sometimes exposed to veld fires, which destroy their ecosystems thereby making them vulnerable to soil erosion by both wind and water. In general, deforestation on the outskirts of Rujeko C Extension has resulted in several negative effects such as:

a) *The disappearance of woodlands*, which have been replaced by grasslands.

b) *Thedestruction of natural ecosystems* resulting in the loss of biological diversity.

c) *Migration of wild creatures* such as monkeys, bush bucks and rabbits due to the destruction of their natural habitats.

d) *Erosion* due to the destruction of the soil's natural protective cover threatens to silt the nearby Shagashi, a major tributary of the Mutirikwi River. Since the city draws its drinking water from Lake Mutirikwi (further downstream), this scenario is a cause for concern.

However, although this environmental crisis is obvious to the public eye and local authority, neither EMA nor the city council has taken any drastic measures to avert it. Their passive reaction seems to encourage wood fuel poachers in their illegal activities.

The Relative Costs of Wood fuel

A comparison of the four main energy sources that are commonly used in the city of Masvingo yields interesting results (Table 6). By far the most expensive source is the candle even though it is only used for lighting, and residents depend on

other sources of energy for cooking. The costs of candles per month range from a minimum of $2 Million to an average of $10 Million up to a maximum of $30 Million per individual household. Wood fuel follows closely with a minimum of $1 Million, an average of $5 Million and a maximum of $20 Million. Paraffin is the third most expensive energy source with a minimum of $500 000.00, an average of $3 Million and a maximum of $5 Million. By far the cheapest source of energy in the city is electricity, which ranges from a minimum of $100 000.00, to an average of $1 Million and a maximum of $3 Million.

It is ironical that the cleanest and relatively cheap source of energy in the city (electricity) has also become the least reliable type due to frequent power cuts by the Zimbabwe Electricity Supply Authority (ZESA). Due to this problem, residents resort to the use of more expensive sources, which are unclean and very costly to them. During the study period, a regular consumer of wood fuel in Rujeko C Extension purchased two bundles of wood fuel (at 15 kgs each) on two consecutive days beginning on the 31st of August 2008. On the first day, the bundle cost Z$80.00 (re-valued currency). On the following day (1st of September), a similar bundle sold for Z$200.00 from the same supplier. The sudden increase in prices is not surprising due to the high rate of inflation in the country. For example, according to *The Worker No. 154*, November 2008, the official inflation rate in the country had reached a record level of 231 Million percent by June of the same year. The shortage of energy for heating and cooking in the city has led to the emergence of informal traders who thrive on wood fuel vending as a business activity.

Even though energy is a serious problem in the city and people now depend heavily on wood fuel, solar energy still remains untapped as only four out of the 52 households interviewed had solar panels. The main reason is that these gadgets are quite expensive and most residents cannot afford them since they have to be imported from neighbouring countries such as South Africa and Botswana. In 1994, a solar panel cost only $20.00 in the local market. By 1996, the price had risen to $30.00. In 2000, it cost $200.00 and by 2006, it had sky rocketed to $20 Million. During the time of the survey, October 2007, its price ranged from $100 Million to $150 Million.

Table 6: Relative Costs of the main Energy Sources in the City in September 2007 in Z$

Energy Source	Minimum Cost	Average Cost	Maximum Cost
Candles	2 000 000.00	10 000 000.00	30 000 000.00
Wood fuel	1 000 000.00	5 000 000.00	20 000 000.00
Paraffin	500 000.00	3 000 000.00	5 000 000.00
Electricity	100 000.00	1 000 000.00	3 000 000.00

IMPLICATIONS FOR SUSTAINABLE DEVELOPMENT

The demand for wood fuel in Masvingo's low-income residential areas has impacted negatively on physical, social and economic aspects of the city. At the physical level, cases of environmental degradation are reflected by numerous patches of denuded woodland and desertified landscapes, which are vulnerable to soil erosion during both dry and wet seasons. The loss of biological diversity, which emanates from such processes, is a cause for concern from an environmental protection perspective. At the social level, the shortage of energy for domestic consumption has led to an upsurge in wood fuel poaching on the outskirts of areas such as Rujeko C Extension. On the economic sphere, the dependence on wood fuel consumes substantial portions of household budgets, which could be channelled to other purposes such as the purchase of basic commodities like food items and clothing. It is ironical that about three decades after independence, the City of Masvingo has not yet achieved the national goal of wood fuel supply sustainability mentioned previously. This has resulted in numerous cases of poaching as shown in this study.

It is also obvious that deforestation and desertification due to wood fuel poaching are not easy to combat unless alternative sources of energy are provided at the household level (Campbell, et al, 1989 and Magadza, 1992). Legislations such as those enshrined in EMA have not been backed by concrete mechanisms at the grass-root level. In order to alleviate the problems discussed in this paper, this study suggests several solutions, which include:

a) *The establishment of a thermal power plant in the city.* There are four reasons for this solution. Firstly, Zimbabwe has huge reserves of coal, which are still untapped (Jourdan, 1995). It can take advantage of this resource, even though it is not a clean source of energy. Secondly, recent developments have shown that the whole SADC Region will continue to experience power shortages in future (Mapira, 2008). As a result, individual countries should develop strategies that are aimed at addressing their energy needs at both local and national levels. Thirdly, Masvingo will soon become a metropolitan city as it continues to grow spatially and demographically and this means a higher demand for energy. Fourthly, the establishment of a thermal power plant in the city can provide a solution to neighbouring settlements such as Nemamwa Growth Point, Morgenster Mission, Mapanzure Rural Service Centre and Mashava Asbestos Mine. Once the plant is established, these centres will no longer have to depend on the national grid for power supplies. At national level, this will be a great saving in terms of foreign currency. It should however, be remembered that thermal plants are great air polluters. Hence their installation should be done in the light of global laws that govern environmental protection and technologies should be developed in such a way that pollution levels are minimized (Miller, 1994 and I.B.R.D, 2002).

b) *The establishment of a hydroelectric power plant at Lake Mutirikwe*, some 30km away. The lake is a major source of water for the city. It was constructed between 1959 and 1961 in order to supply irrigation water to the

S, E. Lowveld estates at Triangle, Hippo Valley and Chiredzi. As a perennial source of water, it can also be used to generate hydroelectric power for the City of Masvingo if a plant is established there. However, its power generation capacity is likely to be limited by frequent droughts, which occur in Zimbabwe. For example, during the 1992 drought, the water level in the lake dropped so severely that the city was in danger of running dry. Hence the plant should not be viewed as a permanent solution. Rather, it should function as one of the alternatives.

c) *Solar Energy alternatives.* This is an area that has not yet received serious attention from consumers. If solar panels were made available and affordable to the ordinary consumer, this would partly solve the city's energy problems. Locally developed technologies are worth considering if this solution has to succeed. Institutions such as hospitals, clinics and schools in the city can also benefit from this clean source of energy.

d) *Wind Energy.* This is another clean source of energy that has not been adequately utilized. Farms and agricultural smallholdings in the outskirts of the city can take advantage of the source especially in the operation of boreholes and pumping water for irrigation.

e) *Energy Saving Strategies.* This study has shown that electricity is the cheapest form of energy in the city. However, it can be made even cheaper for residents if energy-saving strategies are explored. Recent studies indicate that currently used energy meters are inefficient in the measurement of monthly energy consumption levels per household (Munthali, 2004). If this is true, new devices should be developed so as to reflect the true amount of power consumed by domestic appliances. A good example is the one proposed by Munthali in conjunction with the Scientific and Industrial Research Development Centre (SIRDC) Electronics Technology Institute in Harare. Its goal is to reduce the cost of energy that each consumer uses and pays for per month thereby making energy much cheaper for household consumers.

CONCLUSION

Over the years, the city of Masvingo has experienced rapid spatial and demographic growth which, in turn have increased the demand for energy especially at the household level. For example, the establishment of Rujeko low-income residential suburb in 1985, led to massive deforestation on the outskirts of the city, which in turn has resulted in desertification and land degradation in the affected areas. Trees have been cut down in order to meet the ever-increasing demand for wood fuel among residents of the city. Ecosystems have been damaged resulting in the loss of biological diversity. Landscapes deprived of their natural vegetation cover are prone to soil erosion, which has negative impacts on the environment in general. In view of the prevailing environmental crisis, this study has suggested several solutions, which include the development of alternative sources of energy such as: thermal, hydroelectric, solar power and wind energy. In addition, energy-saving devices or meters are also suggested as complementary solutions. The above suggestions, if adopted, can lead to the achievement of sustainable development at city level in the long run.

REFERENCES

Campbell Brian, Du Toit Simon and Attwell Morris, 1989. (Eds) *The Save Study: Relationships between the environment and basic needs satisfaction in the Save Catchment,* Zimbabwe, University of Zimbabwe Publications, Harare.

Central Statistical Office (CSO). 2002 *Population Census 2002 Preliminary Report*, Government Printers.

Child Godfrey and Heath Robin, 1992. “Are Zimbabwe’s Major Vegetation Types Adequately Protected?” *Geographical Journal of Zimbabwe, No. 23:* 20-37.

City of Masvingo 2005: Housing and Community Services Records Office.

Drummond Robert 1981. *Common Trees of the Central Watershed Woodlands of Zimbabwe*, Natural Resources Board, Harare.

Environmental Management Act (CHAPTER 20:27), Government Printers, Harare.

International Bank of Reconstruction and Development (I.B.D.R). 2002 *Building a Sustainable Future: The African Region Environment Strategy,* The World Bank. Washington, D.C.

Jourdan Paul (Ed) 1995.*The Mining Sector in Southern Africa*, SAPES Books, Harare.

Kunaka Charles 1991. “The Railways and the Zimbabwe Coal Crisis of the Late 1980s”, *Geographical Journal of Zimbabwe*, No. 22:1-14.

Lopes Carlos (Ed) 1996. *Balancing Rocks: Environment and Development in Zimbabwe*, SAPES Books, Harare.

Magadza Christopher 1992. *Conservation for Preserving the Environment.* Mambo Press, Gweru.

Mapira Jemitias and Mungwini Pascah 2005. “River Pollution in the City of Masvingo: A Complex Issue”. *Zambezia* Vol. 32 Nos. i/ii: 95-106.

Mapira Jemitias 2008. “Masvingo’s Iron Ore Processing Plant (SIMBI Pvt. Ltd): Impacts on the City’s Economic Development and Environmental Crisis”, *Geographical Journal of Zimbabwe.* Forthcoming.

Miller Tyler 1994. *Living in the Environment: Principles, Connections and Solutions,* Wards worth Publishing Company, California.

Moyo Sam (Ed). 1991. *Zimbabwe’s Environmental Dilemma: Balancing Resource Inequities*, ZERO, Harare.

Munowenyu Earnest 1996. *‘A’ Level Geography: A Comprehensive Guide,* Longman Zimbabwe, Harare.

Munthali Ackim. 2004. “Domestic A.C. Energy Meter”, Unpublished MSc Dissertation, Department of Physics, University of Zimbabwe, Harare.

Scott Stewart 1991. Masvingo Municipality Master Plan Draft Written Statement, Town Engineer’s Department, City of Masvingo.

Shonhai Tendai 2007. ‘An Iron and Steel Industry in Masvingo City (Zimbabwe)’. B.A. Geography Dissertation, Geography and Environmental Science Department, Great Zimbabwe University, Masvingo.

The Worker: Voice of the Labour Movement NO. 154, November 2008.

Whitlow Richard 1988. *Land Degradation in Zimbabwe: A Geographical Study*, Natural Resources Board, Harare.

ABOUT THE AUTHORS:

Jemitias Mapira is a lecturer in Geography and Environmental Science at Great Zimbabwe University (GZU) in the City of Masvingo. He holds a Master of Environmental Science degree from the University of Botswana and a BA in Geography and English from the University of Zimbabwe. He has published over ten articles and three textbooks in Geography and Environmental Science and is currently studying for a PhD in Environmental Education at the University of Stellenbosch in South Africa.

Ackim Munthali is a lecturer in Physics at Great Zimbabwe University. He has a Master of Science degree in Physics from the University of Zimbabwe and a BSc Honours degree in the same discipline from the National University of Science and Technology (NUST) in Bulawayo (Zimbabwe). He was the acting dean of the Faculty of Science at GZU at its inception in 2010.