

Domestic Energy Use of Low Income Households in Grahamstown East

Group 8:

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Abstract

Domestic energy choices have important consequences for the ecological, social and economic environment. Therefore it is important for local level planning to be informed by an awareness of the particular energy use patterns and associated environmental impacts within its territory. The domestic energy situation in South Africa is unique because of Apartheid policies which excluded certain groups of society from access to basic services. Consequently, the democratic government has implemented a widespread electrification programme as well as a 'Free Basic Electricity' programme to meet the energy needs of more than 5 million households. However, little research has been done to assess the impact of electrification and FBE on energy choices in South Africa. This study reports on the domestic energy preferences and trends from 2005 to 2011 for low income households in Grahamstown, Eastern Cape. Results indicate that there is an increasing use of electricity for cooking, heating and lighting. Paraffin remains the preferred fuel for space heating; however the proportion of households using paraffin has decreased significantly since 2005. Fuelwood is not a primary source of energy and the annual demand for fuelwood has fallen dramatically. Also, more households are buying their stocks of fuelwood as opposed to collecting them. Overall, households are moving towards using electricity; however the energy transition is hampered by capacity constraints. Nevertheless, there are opportunities to improve the situation by using renewable energy technology. Moreover, there are innovative opportunities to use the fuelwood market to create local jobs as well as eradicate alien species.

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Reporting Framework and Structure of the Report

The DPSIR reporting framework

This report forms a chapter in a State of the Environment Report (SoER) for Grahamstown, Eastern Cape. A SoER is essentially a document which gathers regional information about the state and trends of the environment (DEAT, 2007:5). The purpose of a SoER is to inform decision-making, increase stakeholder awareness and understanding of their environment, as well as facilitate the measurement of progress towards sustainability (DEAT, 2007:5). To meet these objectives, DEAT (2007:20) recommend that a framework is used to organise the SoER information into a coherent structure. For the purpose of the Grahamstown SoER, a 'DPISR' (Driver-Pressure-Impact-State-Response) framework has been chosen as the organisational reporting framework (**Figure 1**).

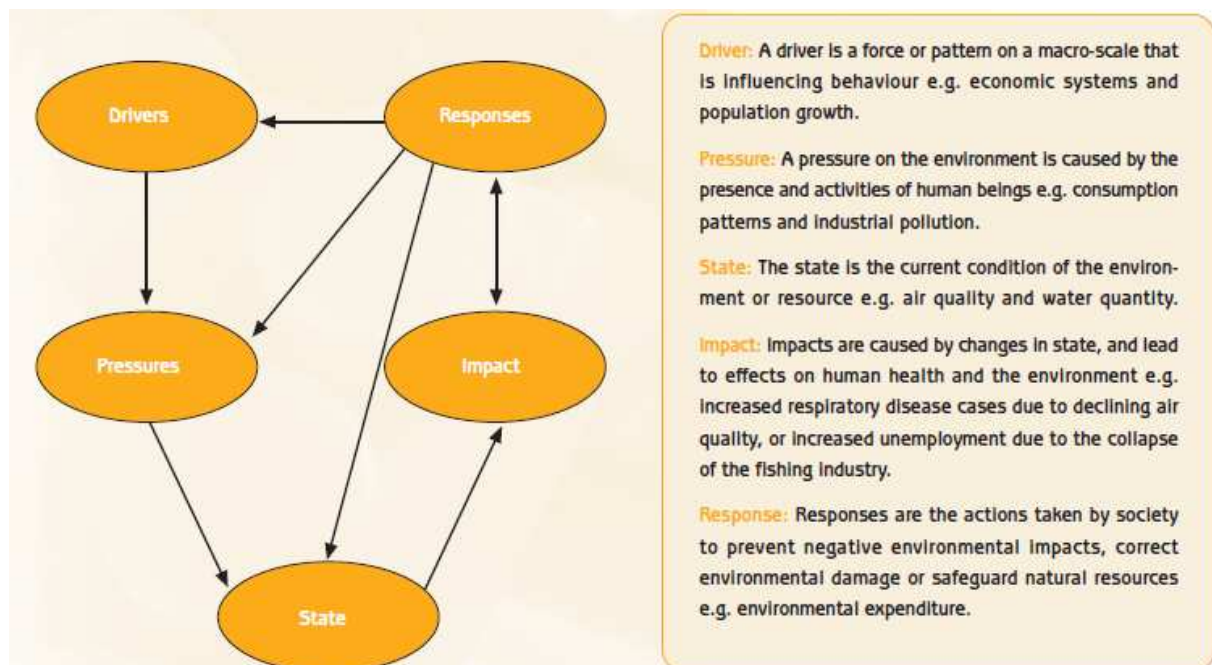


Figure 1: The DPSIR organising framework

(Source: DEAT, 2007)

This paper has seen energy choices as factors which (i) influence human activities such that, when combined with environmental conditions, cause environmental change, and (ii) are themselves pressures on the environment. Therefore, using the definitions of each of the components in the DPSIR (**Figure 1**), this report focuses on energy choices as a part of the 'Driver' and 'Pressure' components of the changing environment in Grahamstown. Furthermore, this paper considers the word 'environment' to include natural, social, and economic components.

The Structure of the Report

The ***Introduction*** firstly explains the issue of domestic energy at a global level, with an emphasis on the importance of energy services and also on the health implications of using traditional energies. Secondly, the introduction covers the issue of domestic energy in developing countries. Issues highlighted are energy poverty and the fuel stacking tendencies of poor households. Also, wood-derived energies are focussed on because of their heavy use in developing countries. Furthermore, aspects of fuelwood use are discussed in terms of negative impacts on the environment. Lastly, the introduction looks at domestic energy in South Africa. It briefly explains the unique energy background of South Africa, and goes on to stress the knowledge gap in assessing the impact of energy policy on low income households. Finally, mention is made of the study by Shackleton *et al.* (2007), on which this project is based.

The ***Objectives*** state the project's aim; namely to inform a broader State of the Environment Report on the energy situation in Grahamstown.

The ***Study Area*** section briefly covers the location, social indicators, and environmental characteristics of Grahamstown.

Methods explain the experimental design and statistical analysis used in the project.

Findings present a combination of the results of the study and discussion about the results. The reason that the sections are not split into the traditional 'Results' and 'Discussion' sections is because it presents a more holistic view of the energy situation in Grahamstown. Furthermore, the Findings section consists of three main subheadings (*1.Current Energy Use Patterns and Preferences, 2.Trends in Energy Use Patterns and Preferences since 2005, and 3.Domestic Energy: Issues and Associated Opportunities/Constraints*) which are used to systematically address key questions 1-5 in the order they appear in the Objectives section.

Lastly, the ***Conclusion*** summarizes the key points of the study.

Introduction

A Global Perspective on Domestic Energy Use

'Energy services' are services that fuel and appliances yield which benefit human wellbeing (Howells *et al.*, 2010:2729; Modi *et al.*, 2006:9). Examples of energy services include heat for cooking, lighting for home or business use, mechanical power for industry, communication, and cooling for refrigeration (Howells *et al.*, 2010:2729; Modi *et al.*, 2006:9). It is generally accepted that energy services are strongly linked to achieving social objectives and economic growth (Howells *et al.*, 2010:2730). For this reason, the United Nations recognises that improved access to energy services is essential for reaching each of the Millennium Development Goals (Modi *et al.*, 2006:4).

There are various sources of energy, ranging from traditional sources (fuelwood, charcoal, kerosene, dung etc) to modern sources (electricity, natural gas, and mechanical power from wind and water kinetics) (Louw *et al.*, 2008:2813). The energy service, rather than the energy source, is the important aspect for an energy user. Consequently users will utilise the source which is readily available and affordable (Howells *et al.*, 2010:2732). In the case of developing countries, traditional energy sources are utilised because they fulfil the availability/affordability criteria (Modi *et al.*, 2006:20). However, traditional energies are seen as inferior in that they are often environmentally degrading, harmful to human health, and unnecessarily inefficient when compared to modern energies (Howells *et al.*, 2010:2730). According to the World Health Organisation (WHO) report on household energy and health, more than 3 billion people worldwide still use biomass and charcoal as energy sources to meet their basic needs (WHO, 2006:8). Consequently, they are vulnerable to hundreds of pollutants which are related to chronic respiratory diseases and lung cancer (WHO, 2006:8).

Domestic Energy in Developing Countries

Energy poverty describes the situation where people suffer from poverty and do not have access to modern energy (Modi *et al.*, 2006:9). These people must rely on traditional energies to meet their basic needs, and are consequently locked into livelihoods which are unnecessarily time consuming, unhealthy, and harmful to the environment (Howells *et al.*, 2010:2730). Sub-Saharan Africa is particularly prone to this type of poverty (Modi *et al.*, 2006:9).

The 'energy ladder' model is often mentioned in discourse on energy in developing countries. The concept proposes that, with economic development, households move up the 'ladder' of energy options, away from traditional energies; known as 'energy transition' (Hosier and Dowd, 1987:347). However, a study done in rural Mexico (Masera *et al.*, 2000:2083-2103) showed that households rather pursue a multiple fuel ('fuel stacking') strategy (using multiple sources of energy to derive energy services). In low income households, fuel stacking is largely attributed to maximising fuel security in the face of irregular employment and income (Louw *et al.*, 2008:2816). A study done by Howells *et al.* (2010:2735-2736) in Nkweletsheni, a small rural South African town, also found that, where households became more affluent, they experienced only a partial energy transition away from biomass to Liquid Petroleum Gas (LPG). Reasons for limited fuel transitions include the additional cost of installing appropriate appliances, poor understanding of the health benefits of using cleaner fuels, exaggerated fears of using LPG, undervalued biomass, informal barter markets and limited access to markets, and cultural custom and norms (Howells *et al.*, 2010:2736). These studies indicate that the energy ladder model is too simplistic, and that household energy security is achieved through a combination of energy sources which are determined by local environmental, economic and social contexts (Madubansi and Shackleton, 2006:4089).

A key energy source in developing countries is fuelwood. Approximately a third of the energy used in southern Africa is from wood, especially for cooking and heating (Biggs *et al.*, 2004:26). Over and above health and economic implications, fuelwood harvesting is concerning in terms of environmental sustainability because it can potentially contribute to land degradation, air pollution, and climate change (Modi *et al.*, 2006:30). The fuel stacking tendencies of low income households in developing countries suggest that wood will continue to be a key source of energy in the future. In fact, the Food and Agriculture Organisation (FAO) (*in* Biggs *et al.*, 2004:26) predicts that wood and charcoal consumption in Africa will increase by 25% and 50% by 2030 respectively.

Domestic Energy in South Africa

South Africa's political history has had a stark impact on the domestic energy situation at present. Apartheid policies left large disparities between racial groups in terms of income, access to basic services and infrastructure; with only 25% of rural black households having access to electricity before 1994 (Bekker *et al.*, 2008:3125). Post-Apartheid government subsequently identified access to modern energy, specifically electricity, as a basic service which should be provided to all citizens, and South Africa underwent a massive electrification programme (Louw *et al.*, 2008:2812). The programme included the electrification of more than 5 million households between 1990 and 2007, the development of new spatial planning and local government administration, technical innovation, and the policy of 'Free Basic Electricity' (FBE; a free monthly 50 kWh to low income households) (Bekker *et al.*, 2008:3125-3136). Nevertheless, only 65 % of FBE households used their full allocation of electricity in 2007 (Eskom, 2007 *in* Bekker *et al.*, 2008:3135). Beyond this, there is limited research assessing the impact of FBE on low income household energy choices and energy poverty in South Africa (Shackleton *et al.*, 2007:5). Also, there has been a recommendation that alternate approaches, such as LPG or sustainable woodlots, be investigated for suitability in energy policy (Bekker *et al.*, 2008:3135; Shackleton *et al.*, 2007:9).

In 2005, Shackleton *et al.* (2007) carried out a study on household fuelwood usage in small electrified towns in the Eastern Cape; one town being the low income section of Grahamstown. Fuelwood usage was chosen as a focal issue because of its implications for energy, environmental degradation, health and social affairs. Shackleton *et al.* (2007) found a high dependence on fuelwood for energy in the low income households. However, the study was a baseline study and lacked conclusions about long term trends in domestic energy use for the region. Within this context, this project proposes a follow-up study of domestic energy use in the low income households of Grahamstown. Furthermore, this project will concurrently serve as a contribution to a State of the Environment Report (SoER) for the Grahamstown area.

Objectives and Key Questions

The main objective of this project is to contribute an assessment of the Grahamstown domestic energy situation to a SoER for the area. Specifically, the objective will be accomplished through a follow-up study of the domestic energy use in low income households in Grahamstown East, based on the study conducted in 2005 by Shackleton *et al.* (2007).

In order to address the aforementioned objective, the following key questions will be answered:

1. What are the current energy use patterns and preferences of low income households in Grahamstown East?
2. With reference to the 2005 study by Shackleton *et al.* (2007) what are the trends in energy use patterns and preferences for the last six years?
3. What is causing the trends found in key question 2?
4. What are the social, economic, and environmental issues related to the drivers and trends identified in key questions 1-3?
5. What are the opportunities and constraints associated with energy use trends in the area?

The overall objective implicitly involves the analysis of findings to make recommendations for local policy formulation and planning, especially with regards to sustainable development.

Study Area

The study was undertaken in Grahamstown (33°18'23, 62''S; 26°31'30, 09''E), a small city situated in the Eastern Cape, South Africa (**Figure 2**). The region around Grahamstown is largely agricultural, comprising mostly of cattle and game farms (Shackleton *et al.*, 2007:5). Mean annual rainfall is approximately 550-600 mm, and the area includes four different climatic zones corresponding to four vegetation types: Grassland, Sub-Tropical Thicket, Cape Fynbos and Karoo (Shackleton *et al.*, 2007:5; Grahamstown handbook, 2010).



Figure 2: Study Area; Grahamstown East
(Adapted from: Bing 2011)

Grahamstown is the administrative centre of the Makana District and has a population of approximately 70 706 people (Shackleton, *et al.*, 2007:5; Makana Municipality, 2010:21).

There has been an increase in informal settlements in Grahamstown, indicating rural-urban migration due to people searching for better job opportunities and service provision (Makana Municipality, 2010:15). Two thirds of the Grahamstown population falls into the economically active category of 15-64 years of age (Makana Municipality, 2010:15). Furthermore, more than 50% of the economically active population (including discouraged workers) is unemployed and only 22% of the population has an education level of grade 12 or higher (Makana Municipality, 2010:16-17).

The project was executed in Grahamstown East (outlined area in **Figure 2**); consisting of ± 9000 out of the total $\pm 11\ 000$ households in Grahamstown. The area is characterised by low income households with predominantly black and coloured inhabitants (Moller *et al.*, 2001:11). Data collected during this study indicate that, while the area is characterised by low income households, there is an improving trend in wealth and housing indicators when compared to the 2005 study (Shackleton *et al.*, 2007:5) (**Table 1**). The area was electrified between 1992 and 1994, and has therefore been electrified for more than 17 years at the time of the survey (Shackleton *et al.*, 2007:5).

Table 1: Selected household characteristics in 2005 and 2011
(Mean \pm Standard Error)

	2005	2011
Mean household size	4.37 \pm 0.19	4.73 \pm 0.33
Mean monthly income (R)	1677.18 \pm 17.48	2064.85 \pm 25.40
Mean monthly expenditure on electricity (R)	98.4 \pm 1.40	117.92 \pm 1.02
Frequency of consumption of meat (x/month)	6.83 \pm 0.75	9.87 \pm 0.70
Rooms per capita	1.03 \pm 0.08	1.16 \pm 0.09

Methods

Data Collection

Data was obtained through two sets of questionnaire-surveys during the period of April to August 2011. One survey examined the energy use profiles of 101 households in Grahamstown East, while the other was used to interview fuelwood vendors in order to obtain information about fuelwood collection and sales.

The household questionnaire comprised of four main sections; namely *Background Information; Energy Sources, Uses and Types; Details about Fuelwood Use; and Electricity Use*. These sections were used to systematically address the project's key questions. Key questions 1 (current energy use patterns and preferences) and 2 (trends in energy use in the last six years) were addressed through closed questions yielding quantitative data. Open-ended questions underwent content analysis, producing qualitative data. These questions allowed respondents to express opinions on drivers of change, key issues, and possible opportunities/constraints (key questions 3, 4 and 5 respectively). Interviews were carried out in the households' primary language, isiXhosa (with the aid of various translators). Fuel types purchased were measured in Rands per month and collected fuelwood was converted into a weight in kilograms. The project revisited the same fully randomized interview schedule of 110 households interviewed by Shackleton *et al.* (2007). In some cases, previously sampled houses were vacant or being renovated and the associated data from the previous study had to be eliminated, resulting in a final sample size of 101 households. The statistical approach used by the project was based on a paired design because of its ability to remove external influencing factors (Utts and Heckard, 2011:407). The paired design therefore allowed the establishment of trends in energy use *ceteris paribus*.

The vendor questionnaire-survey was more informal than the household survey. The questionnaire was comprised of queries about the weight and price of the fuelwood units sold, the species of wood sold, the location of harvesting, and the quantity of fuelwood harvested per week. The questionnaire also asked questions about the vendors' perceptions of fuelwood scarcity, issues around the harvesting/selling of fuelwood, as well as possible opportunities regarding the fuelwood market in Grahamstown East (substantiating the answers given in the household interview with regards to key questions 3, 4 and 5). Beyond obtaining prices and weights, the vendor survey was used to triangulate some of the information obtained in the household survey. Seven vendors were interviewed using a

‘Snowballing’ sampling method wherein a vendor was located, interviewed and then asked where the next vendor could be found. This process was performed repeatedly until the sample reached seven vendors. The seventh vendor expressed uncertainty about the location of other vendors, barring those that had already been asked; possibly indicating that most of the vendors had been interviewed and that the sample size was sufficient. The ‘Snowballing’ approach was useful in this instance because there was no initial information about the number of vendors in the area, or where they could be located.

Data Analysis

All data capture and analysis was done in Excel 2007 as well as the statistical programme “R”. Quantitative data were analysed by calculating means and frequencies. Also, standard deviations were used to calculate the standard errors between observations.

All the data pertaining to the 2005 study were taken from Shackleton *et al.*’s raw data (excluding the households disqualified from the 2011 survey). Two-tailed t tests and chi-squared tests were used where applicable to determine if there were significant trends between 2005 and 2011. Moreover, percentages were calculated as proportions of the sample population.

Qualitative data were analysed using content analysis in which information was sorted into categories of similar response. Thereafter major trends were distinguished and summarized into the text.

Assumptions

It was assumed that survey respondents’ perception of fuelwood scarcity is a reliable indication of fuelwood scarcity in the area around Grahamstown East. Also, it was assumed that an increase in electrification causes more households to use electricity, but that the uptake of electricity will be progressive as households take time to acquire electrical appliances.

Findings

1. Current Energy Use Patterns and Preferences

a) Energy Use Profile

The proportion of households using electricity for cooking and lighting was several times greater than the proportions using paraffin for the same purposes (**Table 2**). Two thirds of the households used paraffin for heating, making it the primary fuel used in this category. Fuelwood was not a major source of energy in any of the functional categories, except for cooking (43.6%, n=101), which is attributed to the use of fuelwood in traditional ceremonies.

Table 2: The proportion (%) of households using particular energy forms for cooking, heating and lighting (n=101)

Purpose	Fuelwood	Paraffin	Electricity
Cooking	43.6	17.8	82.2
Heating	18.8	67.3	6.9
Lighting	0	7.9	91.1

Most of the households in the study (95%, n=101) were electrified, which explains the dominant use of electricity for cooking and lighting. The slow uptake of electricity for heating is consistent with the findings of Madubansi and Shackleton (2006:4085). However, unlike the Madubansi and Shackleton study (2006:4085), this study did not find the continued use of fuelwood for spatial heating but rather the sustained use of paraffin. The preference of paraffin could be explained by the econometric findings of Louw *et al.* (2008:2816), which demonstrate that, for recently electrified low income households in South Africa, the cross-price elasticity of demand for paraffin and electricity is inelastic (meaning that demand for electricity will only increase slightly with an increase in the price for paraffin, *ceteris paribus*). Louw *et al.* (2008:2816) list the following reasons for significant paraffin usage in South African low income households: paraffin is convenient to buy, it can be bought in any quantity, and paraffin appliances are readily available and cheaper to buy than electric appliances. Moreover, the latter study asserts that “the use of electricity is a cost-based decision” (Louw *et al.*, 2008:2816).

Another explanation for the preference of paraffin for heating is that many of these households are still in the process of acquiring electrical appliances. The appliances already

acquired by these households at the time of the study were ‘priority’ appliances such as stoves, kettles, and fridges. Intuitively, appliances such as fridges yield the greatest utility from electrification because they provide the indispensable function of food preservation. Therefore electrical appliances for less important services, such as those used for heating, are purchased at a later stage. Paraffin use is prolonged until households can afford to purchase these relatively luxury electric items (note: a ‘luxury good’ is an economic term for an item with an income elasticity of demand greater than 1).

The above conjecture corresponds with the ‘fuel switching’ hypothesis, which suggests that a household will substitute one type of fuel for another as their economic status changes (Hosier and Dowd, 1987:349). However, a considerable amount (81.2%, n=101) of the surveyed households possessed electrical appliances used for entertainment (e.g. televisions, hi-fi’s, DVD players etc). Entertainment appliances are considered luxury goods; however they are also exclusively electrical appliances. Therefore, it is possible that households purchase certain entertainment goods before they purchase heating appliances because paraffin is a suitable, cheap alternative to electric heaters whereas there are no cheaper substitutes for electricity when it comes to entertainment. Moreover, a study by Hauck and Stanforth (2007:175) suggests that younger generations have a preference for entertainment goods because these goods signify higher social status. This deduction corresponds with the ‘fuel stacking’ hypothesis offered by Masera *et al.* (2000:2083) which proposes that, particularly in developing countries, households adopt a mix of fuel types based on the following four factors: economics of fuel and appliance type and access conditions to fuels; technical characteristics of appliances; cultural preferences; and health impacts.

Nevertheless, the Grahamstown East questionnaire-survey did not focus on the motives for paraffin use *per se*. The explanations offered by this paper are purely exploratory and further research would have to be done to confirm the validity of these hypotheses in the context of the study area.

b) Fuelwood use

Of the 101 households interviewed, 64 said that they consume fuelwood. The annual demand for fuelwood was 456.6 ± 11.83 kg/hh/yr. Using an average unit price of R0.74 /kg, the annual demand equates to a direct use value of approximately R337 /hh/yr (note: the unit price for fuelwood was calculated via the vendor survey). Most of the households used fuelwood for cultural/traditional reasons, such as making Umqombothi (Xhosa beer). All the respondents who mentioned they use fuelwood for traditional reasons confirmed that traditional occasions take place sporadically (usually once or twice a year); indicating that much of the fuelwood demand is inconsistent (a point substantiated by the vendors).

Table 3: The purpose of fuelwood consumption mentioned by fuelwood users (n=64)

Purpose	Proportion of fuelwood users (%)
Cooking	48.4
Heating water for tea	4.7
Space heating (indoors)	4.7
Space heating (outdoors)	29.7
Heating water for washing	1.6
Cultural ceremonies	84.4

The majority (73.8%, n=64) of households using fuelwood bought their supplies, whereas 21.3% collected fuelwood and 4.9% both collected and bought fuelwood. Collecting households earned approximately 48% less compared to the income of buying households (Table 4). Furthermore, the proportion of collecting households with access to electricity is more than 20% lower than for non users or buyers of fuelwood.

Table 4: Household attributes of non users, buyers, and collectors of fuelwood (n=101)

	Non users	Buyers	Collectors
Household size	4.95±0.12	4.65±0.10	4.18±0.25
Monthly income (R)	1738±24	2549±56	1318±77
No. of rooms per capita	1.27±0.03	1.29±0.03	0.99±0.06
% with electricity	97	100	77
Of those with electricity, % owning an electrical stove	89	91	77
Monthly expenditure on electricity (R)	106.76±2.18	134.78±2.93	92.31±5.43
No. of times per month consume meat	11.60±0.25	8.69±0.19	9.09±0.53

Table 4 suggests that households collect fuelwood because they do not have sufficient income to purchase it. Almost a quarter of the collectors do not have access to electricity, and therefore the implication is that these households use fuelwood on a daily basis (as opposed to the infrequent use of fuelwood by households that buy their supplies for traditional ceremonies) and their incomes are not sufficient to cover the cost of frequently buying fuelwood.

With regards to the species preference for fuelwood, collectors preferred *Acacia karroo*. All of the fuelwood vendors sold either one of or a combination of *Eucalyptus spp.* (Blue Gum), *Acacia karroo* (Sweet Thorn) and *Acacia mearnsii* (Black Wattle). The majority (71%, n=7) of vendors agreed that fuelwood is scarce in the commonage areas. Therefore many of the vendors harvested fuelwood on nearby farms, where farmers allowed vendors onto their property to harvest alien species; thus explaining the predominantly alien species composition of fuelwood sold by vendors and consumed by households.

2. Trends in Energy Use Patterns and Preferences since 2005

a) Energy Use Profile

Since 2005 there has been a significant decrease in the overall use of paraffin ($p < 0.05$; $X^2=26.4$); particularly attributed to the decreasing use of paraffin for cooking and lighting. Furthermore, there was an increase in the proportion of households using electricity for cooking and for lighting, with 91.1% ($n=101$) of households using electricity for lighting in 2011. In general, the use of fuelwood and paraffin decreased for all functional categories, while the use of electricity increased across the board. The trend values for the three energy types are summarised in **Table 5** below.

Table 5: A comparison of the proportion (%) of households using particular energy forms for cooking, heating and lighting in 2005 and 2011 (n=101)

Purpose	Year	Fuelwood	Paraffin	Electricity
Cooking	2005	48.2	75.5	62.7
	2011	43.6	17.8	82.2
Heating	2005	30	70	3.6
	2011	18.8	67.3	6.9
Lighting	2005	1.8	31.8	77.3
	2011	0	7.9	91.1
<i>p</i> -value		$p > 0.05$	$p < 0.05$	$p > 0.05$
X^2		2.5	26.4	0.7

Figure 3 shows the spatial distribution of houses electrified in the 44 years before the time of the Shackleton *et al.* 2005 study (green dots) as well as those electrified after the 2005 study (red dots). While there is no clear pattern to indicate that electrification of houses was completed in a systematic manner, more than 30% ($n=101$) of the interviewed households have only been electrified since 2005. Therefore the relatively recent increase in electrification may be a key driver behind the transition towards electricity use in Grahamstown East.

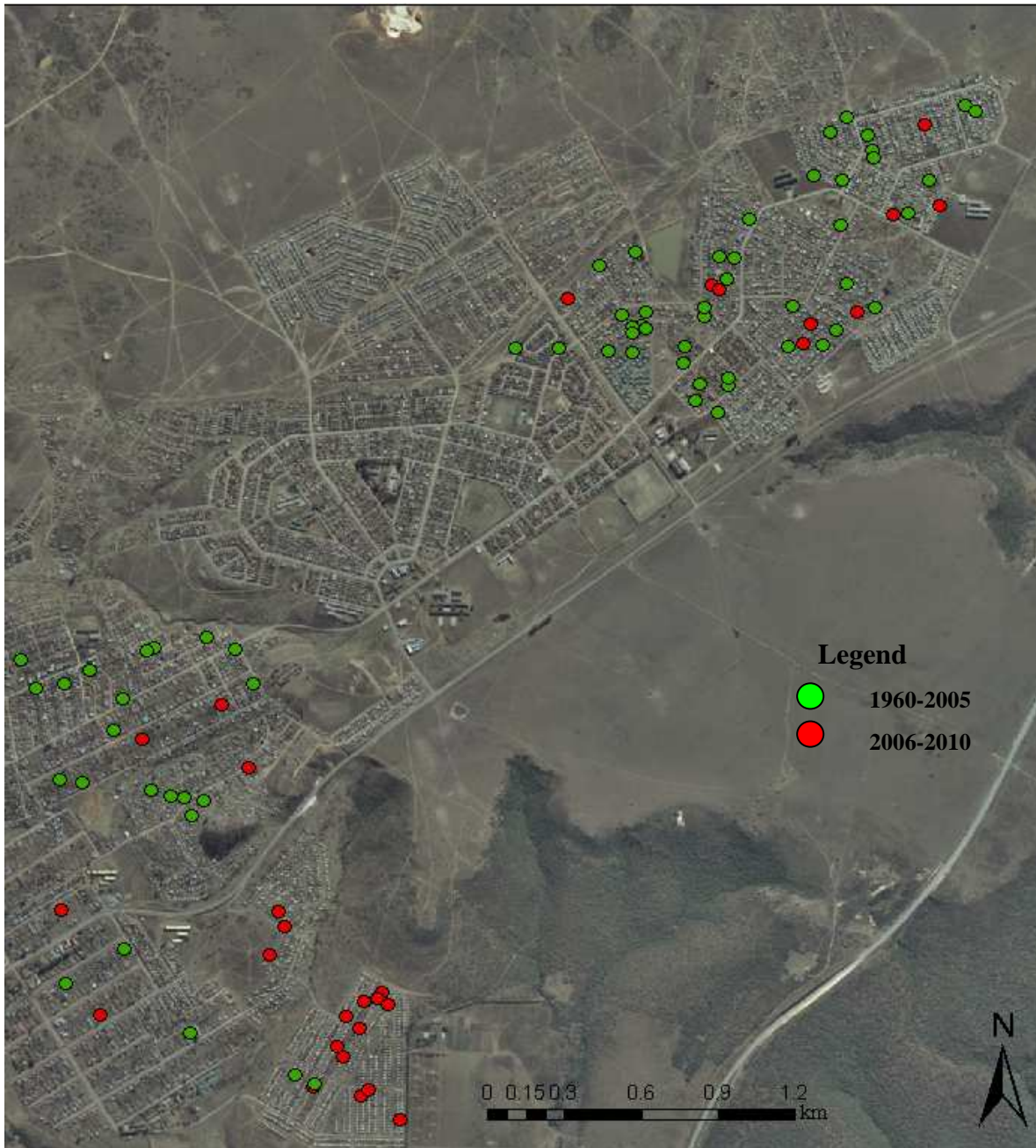


Figure 3: GIS Map showing when sampled households in Grahamstown East were electrified

b) Fuelwood use

There has been a significant decrease ($p < 0.05$) in the annual demand for fuelwood since 2005 (**Figure 4**). Using the 2011 price of fuelwood (R0.74 /kg), the direct use value (in real terms) of fuelwood has decreased by a factor of three; falling from R1034.08 /hh/yr in 2005 to R337.89 /hh/yr in 2011.

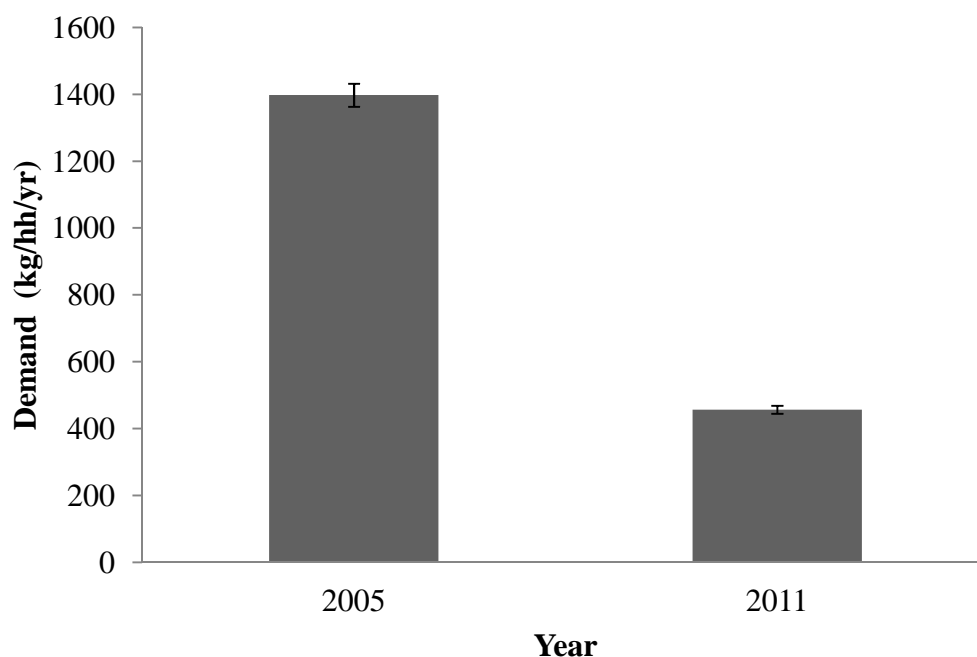


Figure 4: A comparison of the annual demand for fuelwood between 2011 and 2005
(p -value = 7.66×10^{-23} ; $n = 64$)

The decreased demand for fuelwood is attributed to the decrease in fuelwood use for daily cooking, heating and lighting as households have switched to using electricity (**Table 5**). Furthermore, the situation where fuelwood is only used for traditional ceremonies is becoming common. Since traditional ceremonies happen infrequently, far less wood is required by households on an annual basis.

Since 2005, the proportion of households buying fuelwood has increased and the proportion of households collecting fuelwood has decreased (**Figure 5**). This can be attributed to the increasing scarcity of fuelwood stocks; a point verified by all the collectors of wood who said that it is becoming progressively more difficult to find fuelwood. This finding is similar to those observed in a study by Giannecchini *et al.* (2007:34) where a decline in fuelwood availability forced an increasing amount of households to buy wood.

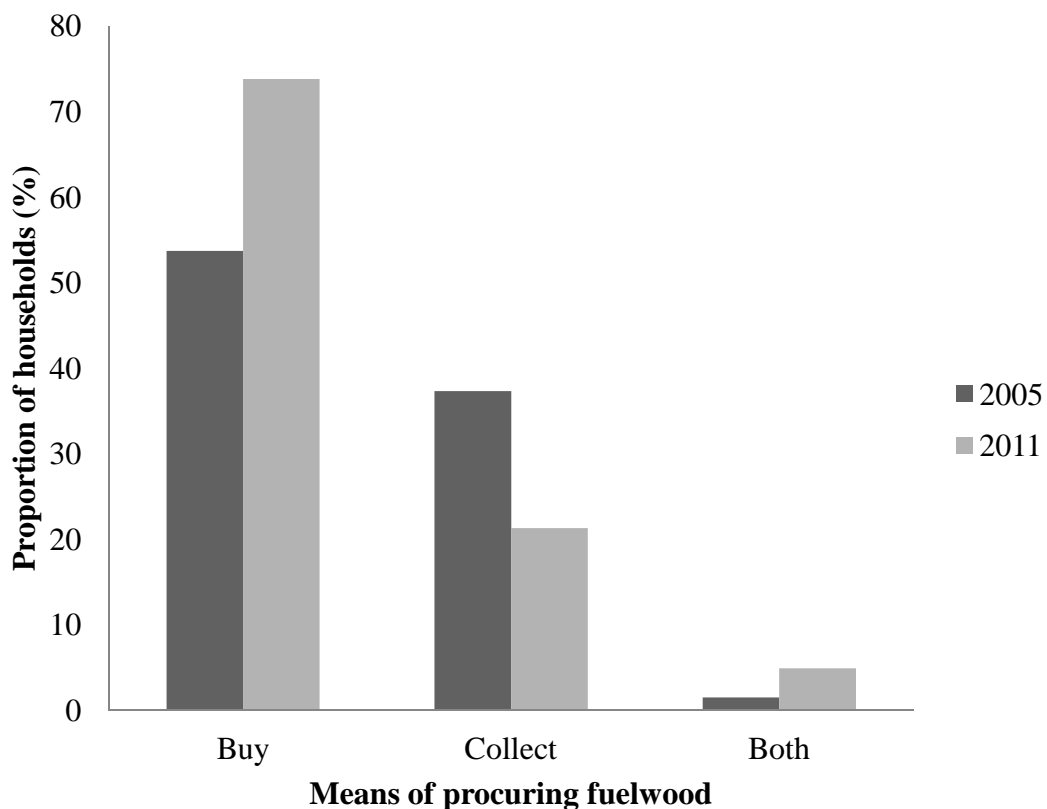


Figure 5: A comparison of proportions (%) of fuelwood-using households mainly buying or collecting their supplies in 2005 and 2011
($X^2 = 9.1$; p -value = 0.01; $n=64$)

With regards to the inference of increasing scarcity of fuelwood, **Figure 6** illustrates that woody and herbaceous vegetation cover is sparsest in areas immediately around the urban extent of Grahamstown and particularly near Grahamstown East. This can be attributed to residents harvesting fuelwood from nearby woody species and using the vicinity for grazing. The boundary between the bare and dense areas to the left of Grahamstown East is a ridge, suggesting that the reason the dense area has not been harvested is because it is not easily accessible. Furthermore, land use change, particularly urban sprawl (**Figure 7**), has replaced lands which were potential sources of fuelwood.

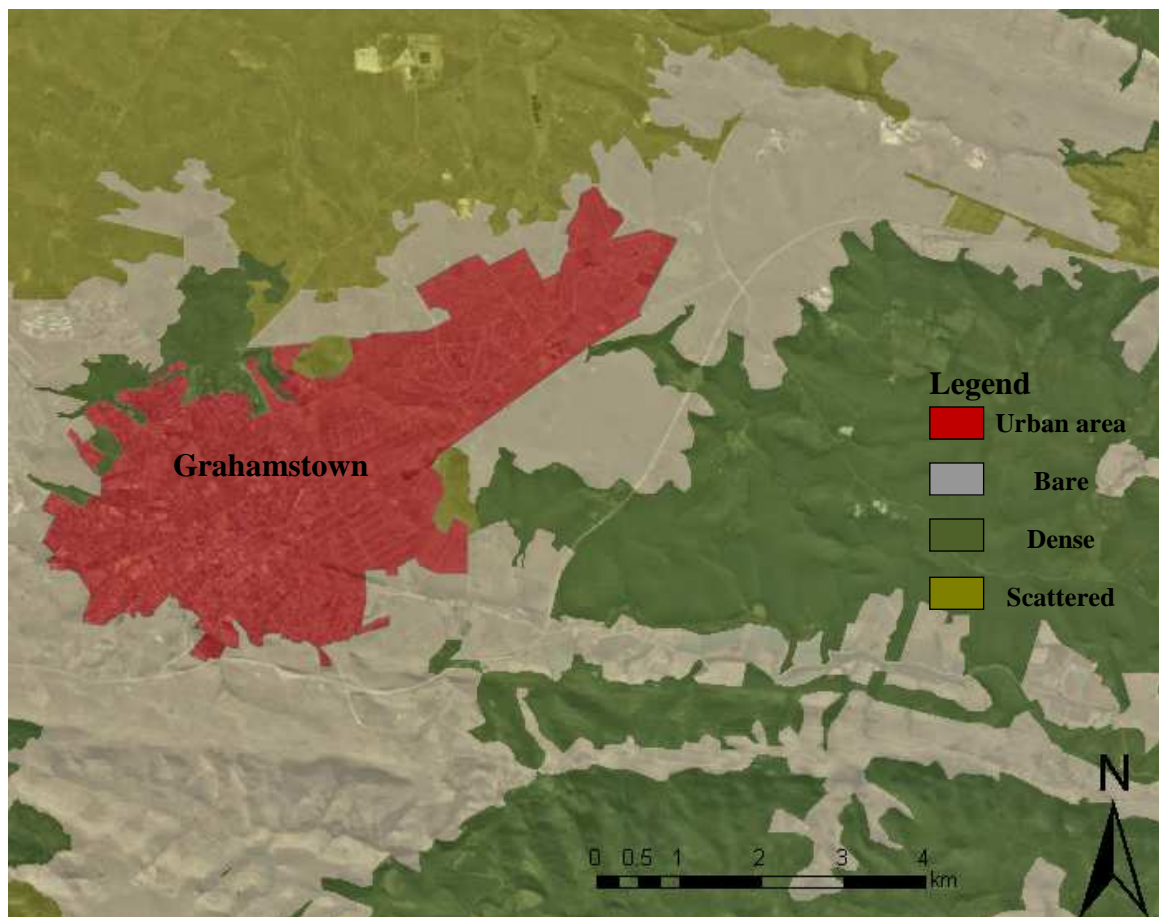


Figure 6: GIS Map showing the extent of woody and herbaceous vegetation cover around Grahamstown in 2009

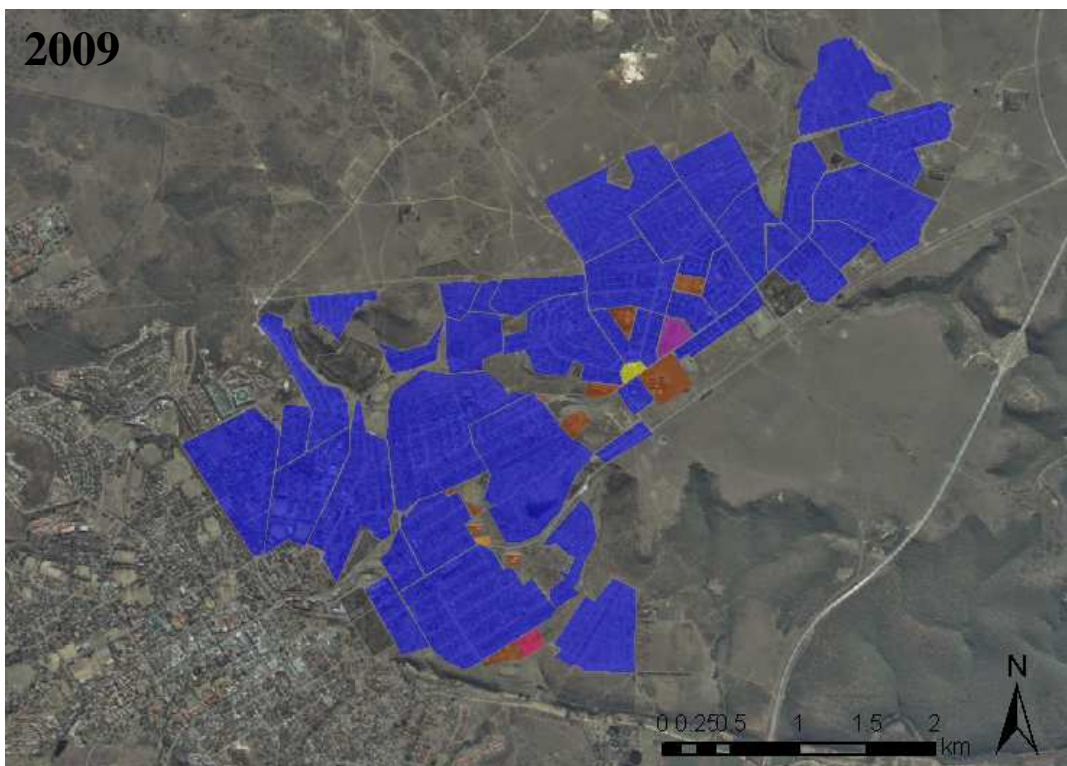
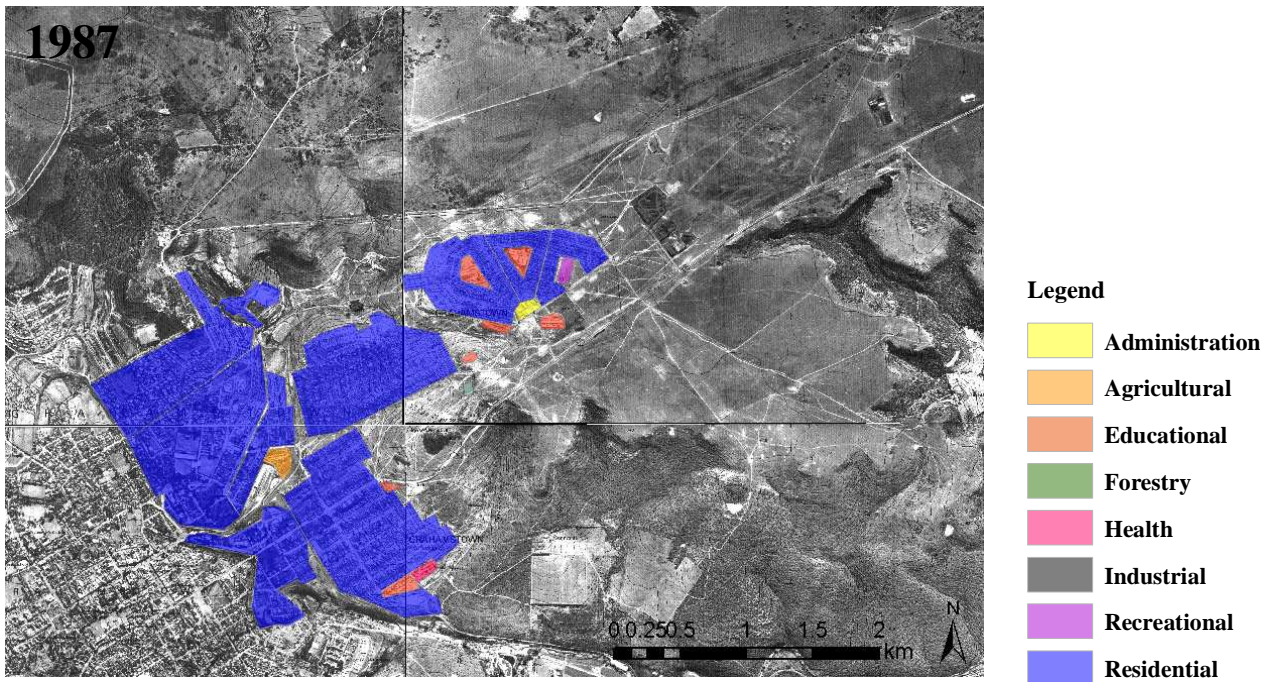


Figure 7: GIS Maps showing the changes in land use in Grahamstown East between 1987 and 2009

3. Domestic Energy: Issues and Associated Opportunities/Constraints

Capacity Constraints and Renewable Energy Opportunities

The majority of households interviewed in this study (77%, n=101) agreed that electricity service provision was unreliable. The problems households faced included inadequate fuses in meter boxes, blackouts, slow response to repairing electrical connections, and electricity being too expensive. Interestingly, there was uncertainty amongst households about FBE and some respondents seemed to think that the municipality is no longer issuing subsidies.

According to Bekker *et al.* (2008:3129) after 2001, Eskom changed to a private corporation and local government became the institution responsible for the provision of basic services, including electricity. The role of municipalities is to reticulate, redistribute, and resell electricity as well as maintain local electricity infrastructure (Makana Municipality, 2010:75). Therefore, many of the problems communicated by households are associated with the general issue of service delivery within Makana Municipality. Furthermore, the 2010/2011 Makana Municipality Integrated Development Plan (IDP) mentions the Electricity Department as one of the departments most affected by shortages in staff capacity (Makana Municipality, 2010:10). Taking the results of this study into account, the human resource problems in Makana Municipality present a crucial constraint to the uptake of electricity by low income households in Grahamstown East.

The Makana IDP (2010:75) also acknowledges the importance of electrifying the substantial backlog of households in the municipality. However, the IDP asserts that the “severe electricity generation capacity constraints” (Makana Municipality, 2010:75) of Eskom will limit electricity supply until at least 2014. The recent US\$ 3.75 billion loan given to Eskom by the World Bank is intended to help improve electricity generation capacity by developing a new coal-fired plant in Medupi and executing a number of other renewable energy projects (World Bank, 2010). South Africa’s electricity supply is primarily generated through coal-fired plants, contributing to 80% of South Africa’s greenhouse gas (GHG) emissions and making South Africa one of the highest per capita CO₂e emitters in the world (Pegels, 2010:4946). South Africa faces a difficult energy future; simultaneously obligated to provide universal access to electricity but to also reduce its level of GHG emissions (Pegels, 2010:4946-4947). However, this study sees an opportunity for achieving both targets at the local level: rather than electrifying the backlog of households, install renewable technology such as solar water heaters. As such, households would ‘skip a step’ in the energy ladder by

moving from traditional energy sources to renewable ones. A similar strategy has been implemented in the Diepsloot Township, Johannesburg (Pye, 2011). In this case, companies invested in building a multi-purpose educational centre entirely powered by an array of 75 solar panels (10.2 Kw) with battery storage (Pye, 2011).

Another case is the 30 000 solar water heaters that have been installed by Eskom in Port Elizabeth (Solar Cells Update, 2011). Eskom aims to install one million solar water heaters across South Africa by 2015 (Solar Cells Update, 2011). Case studies such as Diepsloot and Port Elizabeth provide an achievable example of how electrification in Grahamstown East could be realized through renewable energy, without further straining the limited supply of electricity from coal-fired sources.

Health and Safety

The health and safety concerns associated with energy choices include indoor air pollutants (IAPs), the safety hazard related to using paraffin appliances, and the fire hazard of using traditional fuels (WHO, 2006:11). The health consequences of IAPs include: chronic obstructive lung disease in adults, prenatal mortality, low birth weight, asthma, and cataracts (Edwards and Langpap, 2008:2). The WHO estimated that globally 1.5 million deaths in 2002 were because of air pollution and associated diseases (WHO, 2006:4).

All survey participants (n=55) who responded to the question about ‘counter measures made when using fuelwood as an energy source’ stated that they were aware that indoor fires are bad for one’s health. Of these respondents, only two participants said that they did not take any counter measures, while the rest of the respondents (96.3%, n=55) said that they make their fires outside. In a comparison drawn between the 2005 and 2011 study, there has been a 70.6% (n=101) decrease in the proportion of people that light fires indoors. This could be an indication of a greater awareness of the health issues associated with indoor fires. However, given that paraffin also emits IAPs, the large percentage of households (67.3 %, n=101) using paraffin heaters are not fully aware of the health concerns with regards to indoor heating. Nevertheless, it is suspected that the use of traditional energy sources for heating purposes will be substituted with electricity as households continue to uptake electrical appliances over time (Edwards and Langpap, 2008:3). When asked what how electricity has improved their lives, 32.0% (n=97) said that it was useful for food preservation and 41.2% (n=97) said it made cooking easier. Since food preservation and cooking are important factors in health and

nutrition, it is likely that electrification has improved levels of health in Grahamstown East.

Job Creation

The fuelwood vendor survey revealed that vendors collected wood from various locations including commonages and nearby farms. A number of vendors and their families depended on fuelwood sales as a means of income, but some vendors said that they generated barely enough income to maintain their equipment. The majority of fuelwood users (73.8%, n=64) bought their fuelwood from these vendors; suggesting that there is an opportunity to develop the fuelwood market and thereby create employment in Grahamstown East. With regards to how the market can be developed, Shackleton *et al.* (2004:15) make a point that there is the opportunity for local government to get involved by creating programs for equipping vendors with business skills, introducing a recapitalization program for equipment, or implementing financial incentives (e.g. subsidies) for vendors harvesting wood from sustainably managed sources. However, some effort would have to be made to formalize the market in order for government intervention to be effective (Soussan *et al.*, 1990:577). Many of the vendors mentioned the existence of adversary relations between different fuelwood harvesters. Therefore, to ensure that vendors' rights to harvest particular resources are not undermined, any intervention in the fuelwood market would have to be accompanied by enforcement and the clear communication of ownership and responsibilities (Shackleton *et al.*, 2004:13).

Overharvesting and Environmental Degradation

Most of the vendors (71.4%, n=7) stated that harvesting has become more difficult (compared to five years ago) due to fuelwood scarcity. Moreover, a concerning view expressed by the vendors is that there was conflict between harvesters and livestock owners; threatening to cause an open access, 'tragedy of the commons' scenario in the Grahamstown commonages. Based on the concerns raised by the fuelwood vendors, the system of property rights in Grahamstown commonages seems to be inadequate, ineffective, and a cause of overharvesting. According to Shackleton *et al.* (2004:2), the consequence of unsustainable harvesting of trees is a loss of ecosystem goods and services which further aggravates local poverty. Furthermore, this study identifies poorly implemented communal property rights as a key driver of environmental change (both ecologically and socially) in the Grahamstown region.

The vendor interviews also revealed that nearby farms are popular locations for the harvesting of fuelwood. In some cases, the vendors were approached by farmers who asked them harvest invasive species on farm lands. In other cases, vendors pay a minimal fee (R10/trip) to harvest on farm property. Farms are desirable harvesting locations due to the greater abundance of fuelwood stocks and reduced competition for resources (farmers tend to only allow a few harvesters to access their land for security reasons and only a few vendors have transport to travel to the farms). Consequently, there is the opportunity to formalize the communication between farmers and fuelwood harvesters; an arrangement that would benefit both the farmers (who receive assistance in eradicating alien species without the additional cost of doing it themselves) and the vendors (who get a reliable and abundant source of fuelwood to sell). However, the pitfall of this suggestion is that such an arrangement could be conducive for theft. Explicit rules, consistent monitoring and serious penalties would have to be designed and implemented for the farmer/vendor invasive harvesting to be successful.

The 2005 study by Shackleton *et al.* (2007:9) suggests that managed woodlots are considered as a sustainable option for fuelwood harvesting (especially where urban sprawl is reducing the area of previously woody areas, as is shown in **Figure 7**). During the vendor study, some of the respondents were asked what they thought about a managed woodlot arrangement. The vendors' response was that, while they thought it sounded like a good idea, they felt that conflict between fuelwood harvesters would undermine the sustainability of the woodlots. Again, the issue of an effective property rights system needs to be considered if communal harvesting of any type, be it in managed woodlots or in communal commonages, is to be successful.

Conclusion

Domestic energy use in Grahamstown can be seen as both a driver and manifestation of economic, ecological and social change. This is particularly because of the implications that access to modern fuels, namely electricity, has on bettering the wellbeing of residents who have been excluded from basic amenities due to Apartheid policies.

The current energy use preferences in low income households of Grahamstown consist of electricity for lighting and cooking, and paraffin for heating services. However, fuelwood is not used as a primary source of domestic energy in the area. The mixed fuel consumption pattern reflects households' economic (incomes and FBE subsidy), ecological (land degradation) and social (cultural/ traditional ceremonies) determinants of domestic energy choices.

In terms of domestic energy trends, the demand for fuelwood has decreased significantly since 2005 while the use of electricity has increased, owing to the additional electrification of households in the area.

Pertinent constraints facing the continued energy transition of these low income households include poor municipal service delivery and Eskom's electricity generation constraints. However there are opportunities to meet the electrification backlog via using forms of renewable energy (such as solar panels). Opportunities also exist to increase employment in the fuelwood market through training and financing programs. Furthermore, there is the opportunity to facilitate communication between farmers and harvesters and organize a system in which alien invasive trees are cut and sold as fuelwood. However, the current property rights system in Grahamstown East is a substantial barrier to the effective implementation of any of the recommended policy options.

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