The electrifying impact on the fuelwood resources of a Namaqualand rural community

Lisa M. Price

Electricity pylon (Photograph: Oliver Wood)

Supervisor: Prof. M. T. Hoffman

Submitted in partial fulfilment of the requirements for Botany honours (Ecology)

University of Cape Town, Department of Botany, Rondebosch 7700, South Africa

October

2005

Abstract

Many rural areas in Namaqualand are over-exploiting their fuelwood resources and the South African government is introducing measures to reduce this impact, through the provision of subsidised electricity. The communal village Paulshoek, situated within the Leliefontein reserve received electricity for the first time in 2003. In 1998 an MSc thesis was conducted in the village which observed fuelwood use by the inhabitants and this current project is a comparative study of these results. Data from in-person interviews estimates the change of fuelwood usage in terms of consumption patterns and reveals which wealth classes, Upper Wealth Class or Lower Wealth Class, have benefited more from the introduction of electricity. Electricity has largely replaced fuelwood as an energy source for wealthier households, while less wealthy households are still relatively reliant on fuelwood as a source of energy as their access to income restricts them from buying as much electricity. Traditional use of fuelwood for small fires in the mornings and for baking bread once a week still continues in many households, irrespective of wealth class. The majority of households have seen an improved quality of living with the introduction of electricity, through access to media and better cooking facilities. The reduction in fuelwood collection improved the condition of the veld surrounding Paulshoek.

Introduction

Fuelwood utilisation in rural communities across the globe has been a contentious issue for many years. Dependence on fuelwood as the major energy source in rural areas of many developing countries has become recognised as a fuelwood crisis (DeWees 1989). A large part of the third world depends primarily on biomass fuel (low-energy sources), as opposed to fossil fuels (high-energy sources), relied upon in the developed world (Bhatt & Sachan 2004). Biomass fuels account for 35% of energy supplies in the developing countries (World Bank 1992). An estimate shows that fuelwood accounts for 84.2% of total wood production in developing countries and 12.3% in developed countries (Miah *et al.* 2003). Frequently fuelwood is perceived as a free good for every household in the community (Bembridge & Tarlton, 1990). Therefore in many communal areas wood resources are under increasing pressure (Hoffman 2000). Deforestation in South Africa's rural areas has been recognised as a problem; however fuelwood consumption studies have only been constructed since the late 1970s (Hoffman 2000). With an increasing demand for forest products, paralleled with a decreasing sustainable yield, the crisis has a range of negative consequences on the environment, including loss of biodiversity, deterioration of ecosystem services, soil erosion, increased flooding, and contributing to climate change (Heltberg *et al.* 2000; Hoffman 2000). A better understanding of the underlying mechanisms of this crisis (especially the determinants of rural household fuel substitution) is believed to be essential in addressing it (Heltberg *et al.* 2000). South Africa is classified as a third world developing country (Payne 1992) and the fuelwood crisis is relevant and important to this nation. The area that forms the focus of this study is a rural village in Namaqualand, South Africa called Paulshoek. Namaqualand falls within the winter-rainfall region of SA's Succulent Karoo Biome. While rainfall is extremely low, often less than 150mm per annum, it is characteristically predictable (Desmet & Cowling 1999). Paulshoek is one of nine villages that compromise the Leliefontein communal Reserve. Eight communal areas across Namaqualand account for 26.3% of the area and accommodate 45.4% of the population (Hoffman

(Bembridge & Tarlton, 1990). Arnold & Persson (2003) suggested that countries should combat the fuelwood crisis by growing plantations. However, a great deal remains to be learned about how woodlots should be managed to ensure maximum sustainable yield (Hoffman 2000; Bembridge & Tarlton, 1990). Arnold *et al.* (2003) state that forestry interventions, to stimulate increased fuelwood production from new plantations, have only a limited role in meeting the greater part of the fuelwood demand. In Namaqualand there is little point in creating plantations because the rural communities are so widely dispersed and this option would not be cost effective. It was therefore necessary to supply the community with the next efficient and convenient fuel; electricity (Arnold *et al.* 2003).

A study by An *et al.* (2002), in Wolong Nature Reserve (China), found that electricity, though available throughout Wolong, did not replaced fuelwood as an energy source. Households within the reserve used fuelwood as their energy source for cooking and heating in winter. Households within the reserve used electricity mainly for lighting and some electronic appliances, and only a small proportion of them used electricity for cooking and heating. The use of fuelwood was still prevalent regardless of regulations that were attempted to be enforced on fuelwood collection. It was found that it was becoming increasingly difficult to collect fuelwood due to a shrinking forest area and harsh topographical conditions. Despite the restrictions and difficulties of collecting fuelwood, the majority of local households continued to use fuelwood as their main energy source, even though electricity was available throughout the reserve. An *et al.* (2002) believe the lack of support for the switch to electricity was due to the electricity price and quality.

A major shift from the use of traditional biomass fuels to "modern" fossil fuels and electricity has always been a fundamental feature of economic growth. As incomes rise and more people and businesses can afford to pay for the greater convenience, cleanliness and versatility of modern fuels, the energy system is forced to respond by trying to improve their supply and distribution.

et al. 1999). These large areas of rural lands are structured under the apartheid government and have resulted in the exploitation of large amounts of fuelwood due to high population numbers and poverty.

Indigenous woodlands provide far more than fuelwood; they also supply fodder for animals, fruit, medicines, fibres and a host of other necessities of rural life (Bembridge & Tarlton, 1990). With the growing human and livestock population pressure on land in the former Ciskei and elsewhere in Southern Africa, heavy dependence on fuelwood produced through natural regeneration often affects the amount available, since the time required for the natural regeneration has to be shortened (Bembridge & Tarlton, 1990). This has important consequences for continuing supplies of fuelwood and for the gathering time. Overcutting of fuelwood may occur which creates severe environmental problems and affects soil fertility restoration and agricultural productivity. Collection of fuelwood is, however, not the primary cause of deforestation in some areas, but is certainly a contributing factor. In South Africa, the role of betterment planning has played an important role as people have been resettled at high population densities without the provision of basic services such as electricity making them very dependent on natural resources for their basic needs (Hoffman 2000). Paulshoek is a community which was formed due to the Land Settlement Act (Rhode *et al.*), and ensuing overpopulation and poverty resulted in it being reliant on the surrounding natural resources. The popular image of rural people bringing an energy crisis upon themselves by wasteful use of fuelwood underestimates the skills and perceptiveness of rural people. Although fuelwood consumption tends to be higher where wood is readily available, the economic use of fuelwood is second nature to people (Bembridge & Tarlton, 1990).

Many rural areas in developing parts of southern Africa are today faced with an energy crisis through rapid depletion of fuelwood resources which provide the principal, and in some cases only, source of fuel. The shortages are manifest in the longer hours spent, especially by women and children, in gathering fuel

Despite the heavy dependence on the open fire by large segments of rural households, its use is coupled with problems. These include smoke which often irritates the eyes and provokes respiratory problems due to emissions of polycyclic organic matter and carbon monoxide (Spalding-Fecher 2005). Then there is the ever present fire hazard and the possibility of incurring burns in the process of cooking. Smoke and ash also increase pollution in the areas where fires are made.

The electrification programme in South Africa is focused on supplying electricity to rural areas of South Africa. The Paulshoek village received electricity in August 2003. There are substantial benefits being derived from this programme through its contribution to social poverty alleviation, providing households with access to modern energy and with its potential to reduce indoor pollution and biomass depletion. It also contributes to improved living standards through better lighting, cooking, and media access. An aspect of this study attempts to assess the social changes that have occurred in Paulshoek since the introduction of electricity.

A similar study, used throughout this paper for purpose of comparison, was conducted by Anastelle Solomon, in Paulshoek in 2000. She observed socio-economic aspects, relating to fuelwood, over a time period of two years, starting in June 1997. Solomon (2000) covered a broad range of topics relating to fuelwod use and only a portion of her results will be used for comparison during this study. Her findings include: fuelwood was used for a variety of purposes such as cooking, heating, ironing and baking. Species considered as good quality firewood (e.g. *Rhus undulata*) were used for in-house activities such as cooking, heating and ironing, while low quality fuelwood were used for baking and kindling. She also found that households used on average 8.7 kg of fuelwood per day, wood collectors walked approximately 7.2 km to collect wood and the upper wealth class (UWC) used less wood than the lower wealth class (LWC). In 1998 the community of Paulshoek was harvesting fuelwood at an unsustainable rate (Solomon 2000).

Our study is significant for a number of reasons. First this research will facilitate local management of the reserve in a socially-acceptable, economically-feasible, and ecologically-sound manner. Secondly, the framework and interview methods developed in this study could be useful for similar studies, especially those in developing countries.

In order to assess the changes that have occurred since the introduction of electricity this study has three main aims. The first aim is to assess whether the presence of electricity in the village has altered fuelwood consumption patterns. This will be done by discussing the harvesting of wood in kg's per day, the types of wood used; how often fuelwood is utilised within each household and for which activities it is used. To better understand consumption in relation to wood collection, the distances travelled to collect wood and how often it is collected will be determined. The second aim of this study is to determine which households have benefited from the provision of electricity. This will be assessed according to the number of people in the house still utilising fuelwood, what domestic tasks each wealth class (upper or lower) uses wood for and their expenditure on energy sources. The last aim relates to the social aspects of introducing electricity. The results from this survey are compared to other studies relating to this topic and to national statistics in order to determine the impact electricity has had on the social well-being of Paulshoek inhabitants.

Methods

Study site

Namaqualand falls within the Northern Cape Province (Fig. 1) and is sparsely populated by about 66 000 people. The Leliefontein Rural Reserve is 192 719 ha in extent and is comprised of 10 widely dispersed villages. Paulshoek falls within this Rural Reserve, is located at 30°24'S; 18°08'E and covers an area of approximately 20 000ha (Fig. 1). Paulshoek is characterised by high unemployment rates, relatively high settlement density, overgrazing and a skewed demographic structure, with many very young and older village inhabitants (Hoffman 1999; Rhode *et al.* 2003).

Paulshoek is situated on the eastern slopes of the Kamiesberg and is comprised largely of the foothills of the Kamiesberg escarpment and changes to Bushmanland in the east (Todd & Hoffman 1999). The mean annual temperature for Paulshoek is 16°C, while the mean-maximum temperature for the hottest summer month (January) is 30°C and the mean-minimum temperature for the coldest month (July) is 3°C (Rhode *et al.* 2003). Water is obtained from boreholes and dug wells as there are no perennial rivers in the area (Allsopp *et al.* 1999).

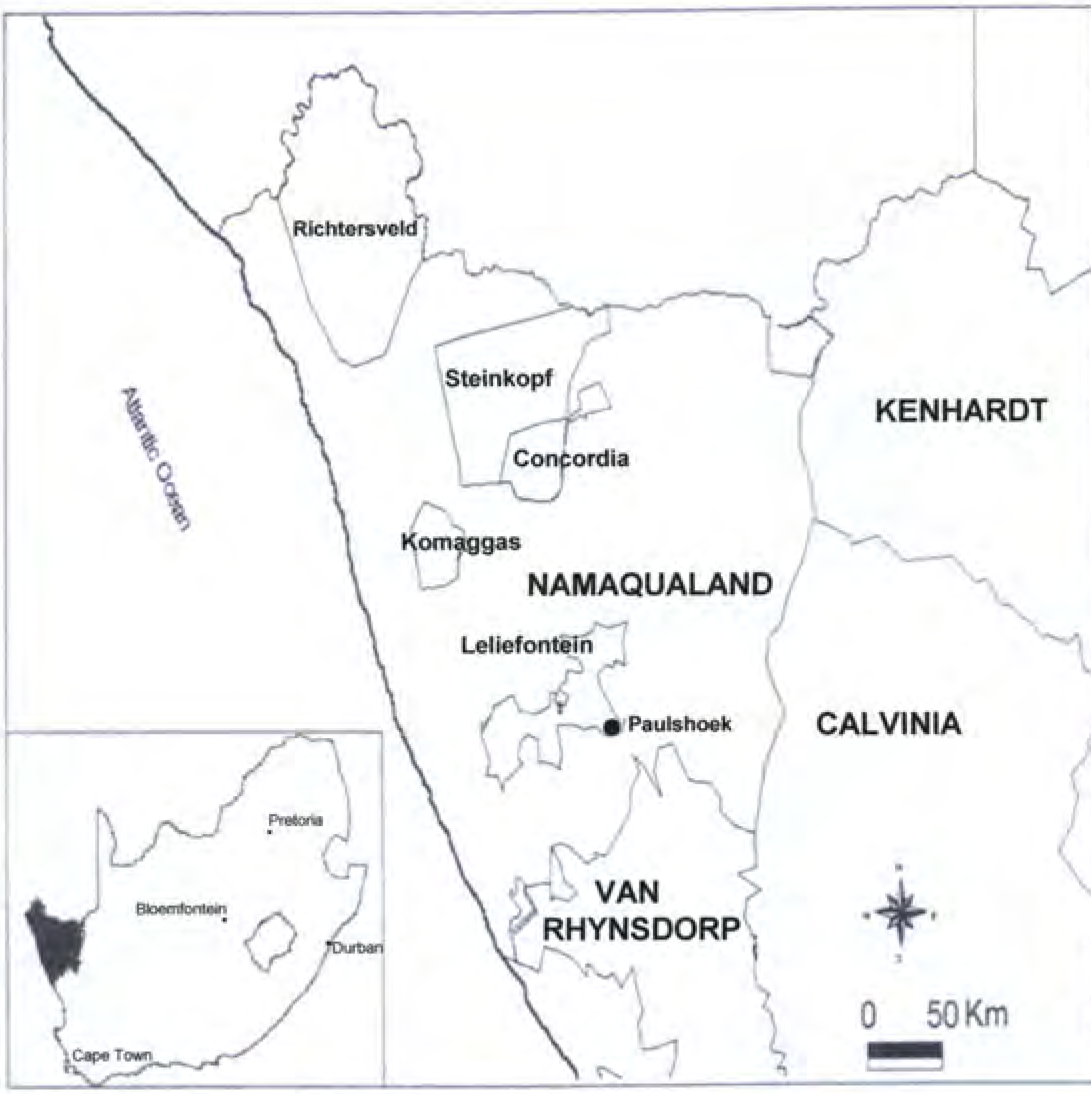

Fig. 1: Map displaying the magisterial district of Namaqualand in relation to the rest of South Africa. The location of the Leliefontein Rural Reserve and the village of Paulshoek are marked on the map. The boundaries of other communal areas in Namqualand are also shown.

Two main veld types (Acocks 1988) dominate the Paulshoek vegetation. The steep climatic gradients in Paulshoek are mainly responsible for the rapid transition between these two distinct vegetation types. The gradient results in Mountain Renosterveld plants, at higher altitudes to the west of the village and mostly dwarf shrubs and leaf succulent shrubs east of Paulshoek (Todd and Hoffman 1999).

The community is made up of an Afrikaans-speaking population. Paulshoek is politically and socially marginalised due to its remote geographical setting. However, Paulshoek is still highly dependent on, and connected with the outside world through migrant labour, state welfare and kinship networks. The resident population of Paulshoek is approximately 600 people, in 130 households (Rhode *et al.*, 2003), many of them shacks, scattered across the landscape (Fig. 2). There are new Reconstruction and Development Program (RDP) houses being constructed in the village at present and a new village tourist camp is located at the western edge of the settlement.

A questionnaire was used to collect data for this study (Appendix 1). Seventy four households were selected at random. A local Afrikaans-speaking woman (Ms Elizabeth Claasen) carried out the in-person interviews under my supervision and guidance. On each topic the respondent was free to express his/her views. New avenues of questioning were pursued as the interview developed. While conducting the interview, the comments of housewives were emphasised, as they were the end user of biomass fuel.

General information regarding the names of the interviewer and interviewee, the household address and the interviewee's age and gender were recorded for future reference. A wealth ranking, Upper Wealth Class (UWC) or Lower Wealth Class (LWC), was assigned to each household, based on many factors. These include: monthly income (income was used as a basis for stratification, because of the fact that it is a critical variable in any economic study related to fuelwood use) (Gaunt 2005), diversity of appliances, means of transport and input from local informants. Monthly income is received in the form of a salary or pension. Appliances are the types of appliances found in the house and their worth was estimated and included into the wealth ranking. A measure of transport is based on the form of transport each household owns, whether it is a car, bakkie, donkey or other. Local informants helped to distribute each household into a wealth class based on previous knowledge of the family and their status within the community.

In order to get a measure of the kilograms of fuelwood used per day in each household, the frequency of fuelwood use was recorded. The frequency options were; every day, every second day, twice a week, once a week, every second week or once a month. The approximate number of kilograms used at each time period was incorporated with the frequency, to get a daily kilogram usage. The kilograms of each type of wood used, either *Rhus undulata* or mixed species, was recorded. *Rhus undulata* was measured separately from the rest of the wood because it forms coals, burns for long periods and is highly preferred by inhabitants of Paulshoek, who describe it as a high quality wood (Solomon, 2000). This species is thus utilised for the main in-house activities like cooking, heating and ironing. This species is not utilised for baking, which is conducted in an outside oven (Fig. 4), as it is considered a waste of good quality fuelwood. A measure of the use of this species can then give a good measure of what activities fuelwood is being utilised for. The number of people resident in each household was recorded in order to get a measure of fuelwood use per person. A measure of the amount of wood that was present at each house was weighed, using a spring balance (Fig. 3). However, only a very small proportion of the sampled population retained wood at their residence.

Each household was asked what types of energy resources they used in 1998 and 2005 for domestic tasks such as cooking, space heating, lighting, baking, heating water, ironing and braaing. Braaing takes place outside the household. Cooking, baking and braaing are all distinguished as separate means of cooking food. The energy sources that were listed were as follows: electricity (obviously not used in 1998), wood, gas, paraffin, candles and other.

Respondents were then asked questions relating to fuelwood collection. The questions included, what transport they used to collect wood, i.e. car, donkey, walking, whether they bought wood or whether they do not collect. They were asked how many times they had collected wood in the last five days, which was compared to the same data from Solomon (2000). To understand how far people were willing to travel to collect wood they were asked what was the furthest they had travelled to collect wood in 2005.

An important aspect of this study is the expenditure of each household on each type of energy source as mentioned above. The interviewee was asked to approximate how much they spent each month on each type of energy source in 1998 and 2005. The electrical appliances that each household owned were also listed. This was used as part of the wealth class calculation and as a measure of the quality of life within the household. General questions were asked, relating to the veld condition. This answer, and answers from continued discussions were used to gain a better understanding of the fuelwood situation and opinion of the villages. They were not incorporated into the data set for this study and will be drawn on for general comment during this paper.

Data, including results from statistical analyses, is taken directly from Solomon (2000). In order to determine whether there was a significant difference between household size and the mean weight of fuelwood used per day, a one-way ANOVA was performed using STATISTICA version 7 (StatSoft). The same test was used to determine whether there was a significant difference in the overall amount of fuelwood used between each wealth class (StatSoft).

A trip was also made to a single stockpost in order to gauge the possible change in fuelwood use since 1998.

Fig. 2: Photo displaying a portion of the village of Paulshoek. (Photograph: Lisa Price, May 2005)

Fig. 3: Photograph of Ms Elizabeth Claasen holding a spring balance which was used for weighing wood. (Photograph: Lisa Price, May 2005)

Fig. 4: Photograph of a wood oven, used for baking by residents in Paulshoek. (Photograph: Lisa Price, May 2005)

Results

Consumption patterns of fuelwood use

Figure 5 clearly shows a shift in frequency in fuelwood consumption where, in 1998 the mode for all households was found to be daily, whereas in 2005 the data indicates a modal class of once a week. In 1998 the data is skewed to the right whereas it is evenly distributed on either side of the mean value in 2005.

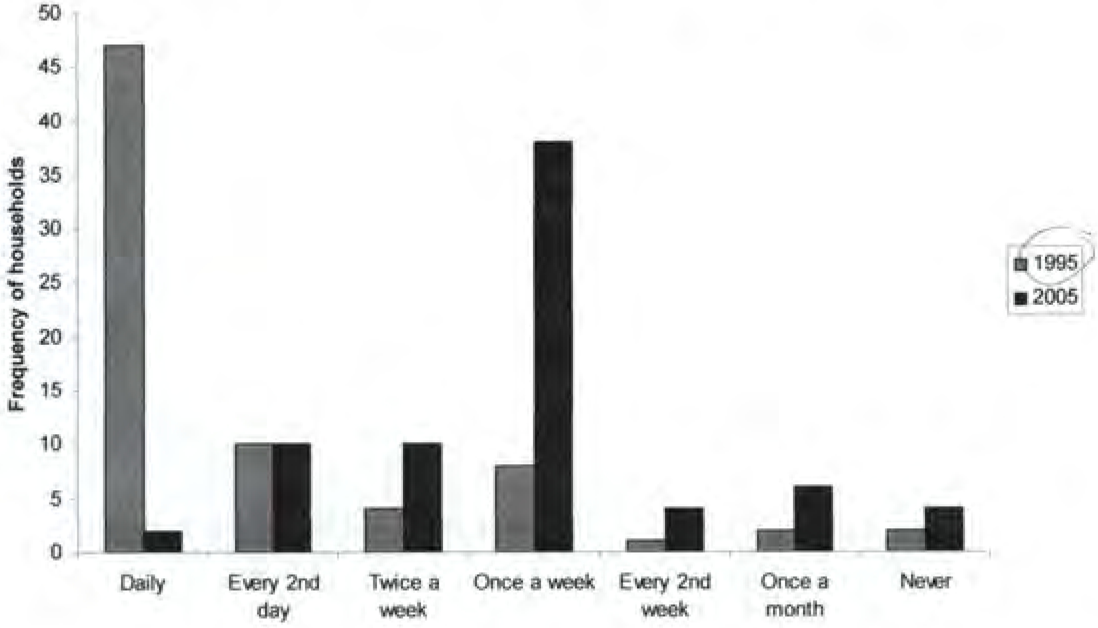

Fig. 5: Frequency of fuelwood use for 1998 and 2005, i.e. whether a household uses wood daily, every second day etc. The results were obtained from a questionnaire survey (Appendix 1) of 50 households in the village of Paulshoek in June 1998 (Solomon, 2000) and 74 households in May 2005.

The mean estimated weight of fuelwood used per day in 1998 was 6.8 kg per day. While the equivalent value for 2005 is 1.7 kg per day (Table 1). Solomon (1998) found a significant difference between household size and the mean weight of fuelwood used per day (n=50; F = 9,99; df = 3; $p < 0.05$). In 2005 there is no significant difference in fuelwood use in relation to household size (n = 74; F = 0.091; df = 2; p = 0.913).

Table 1: The mean weight of daily fuelwood use (kg/day) in each household class (no. of people in a household) for 1998 and 2005. The change in the proportion of fuelwood use in 1998 and 2005 is shown. The results were obtained from a questionnaire survey of 50 households in the village of Paulshoek in June 1998 (Solomon, 2000) and 74 households in May 2005 (Appendix 1).

No. of people in household	No of households		Estimated mean weight of daily fuelwood use		Proportional difference of fuelwood use
	(n=50)	(n=74)	(kg/day)		(%)
	1998	2005	1998	2005	
1-2	7	25	6.0	1.6	-73.3
3-5	21	37	6.2	1.7	-72.6
>5	12	12	8.1	1.8	-77.8
Mean			6.8	1.7	-75

There is less difference in the quality of fuelwood, used in 2005 than 1998, for both wealth classes (Table 2). There is no significant difference in the overall amount of fuelwood used between each wealth class in 2005 ($F = 0.013$; $df = 1$; $p = 0.908$).

Table 2: Measured quantities (kg) of *Rhus undulata* (Rhus) and a Mixture of other fuelwood species used by households in Paulshoek village on a daily basis in June 1998 (Solomon, 2000) and May 2005. The results were obtained from a questionnaire survey (Appendix 1) of 50 households in the village of Paulshoek in June 1998 (Solomon, 2000) and 74 households in May 2005.

Wealth rank	Mean ± std. dev			
	Rhus (kg)	Mixed (kg)	Rhus (kg)	Mixed (kg)
	1998		2005	
Upper wealth class	2.1 ± 1.5	6.7 ± 0.7	0.6 ± 0.8	1.1 ± 0.7
Lower wealth class	5.8 ± 0.6	2.7 ± 1.6	0.6 ± 0.6	1.1 ± 0.6

The mean distance travelled (km) to collect wood (Table 3) has almost halved since 1998, with people now only having to walk on average 4.3 km. The number of trips to collect fuelwood in five days (Table 3) decreased by two thirds and on average people walked to collect fuelwood about once every five days.

Table 3: Approximate mean (± std dev) distance (km) travelled to collect fuelwood (round trip) and number of trips in the previous five days in 1998 and 2005. The results were obtained from a questionnaire survey (Appendix 1) of 50 households in the village of Paulshoek in June 1998 (Solomon 2000) and 74 households in May 2005.

	Mean ± std. dev	
	1998	2005
Distance travelled (km) to collect fuelwood (round trip)	7.2±3.2	4.3±2.6
No. of trips in five days	2.7±1.0	0.9±0.7

Benefits to the community

The amount of fuelwood being used for all domestic uses has decreased from 1998 to 2005 in both wealth classes. The use of fuelwood has decreased by more within the Upper Wealth Class. The area that has seen the most amount of change in domestic tasks relative to the others is ironing. The change in fuelwood use for baking is from 95.95% in 1995 to 85.1% in 2005. This change is relatively small in comparison to the changes in use for other domestic activities. A similarly small decrease in fuelwood use was found for space heating.

Table 4: Percentage of households in each wealth class: upper wealth class (UWC, n = 37) and lower wealth class (LWC, n = 37) utilising fuelwood for each type of domestic purpose. The results were obtained from a questionnaire survey (Appendix 1) of 50 households in the village of Paulshoek in June 1998 (Solomon 2000) and 74 households in May 2005.

Domestic purpose	% of households using fuelwood					
	UWC	**LWC**	**UWC**	**LWC**	**Total**	
	1998		**2005**		**1998**	**2005**
Baking	94.6	97.3	78.4	91.9	95.9	85.1
Space heating	94.6	97.3	59.5	81.1	95.9	70.3
Cooking	78.4	75.7	2.7	21.6	77.0	12.2
Boiling water	32.4	56.8	0.0	8.1	44.6	4.1
Ironing	32.43	51.35	0	5.41	41.9	2.7

The UWC spend more money than the LWC on electricity and wood (Table 5). The LWC spend more than the UWC on gas, paraffin and candles.

Table 5: Approximate mean percentage (± std dev) of household expenditure per month on each energy resource, according to different wealth rankings: upper wealth class (UWC, n = 37) and lower wealth class (LWC, n = 37): 1998 and 2005

	mean % (± std dev) of household expenditure per month	
	1998	**2005**
Electricity		
UWC	0	36.5 ± 20.7
LWC	0	22.4 ± 16.2
Wood		
UWC	14.9 ± 21.8	8.6 ± 16.3
LWC	4.3 ± 13.0	1.8 ± 8.3
Gas		
UWC	69.9 ± 17.8	50.8 ± 24.6
LWC	68.8 ± 27.2	66.4 ± 24.2
Paraffin		
UWC	2.8 ± 3.1	0.3 ± 1.0
LWC	5.1 ± 10.6	0.5 ± 2.4
Candles		
UWC	12.4 ± 6.1	3.7 ± 2.2
LWC	21.9 ± 22.2	8.9 ± 13.0

The price on average of wood has inflated by 1,43 times since 1998 (Table 6), gas by 2,3 times, paraffin by 3,4 and candles by 1,6. Paraffin has the highest increase in price, followed by gas, candles and then wood.

Table 6: Price of energy sources: 1998 and 2005

Energy source	Price	
	1998	2005
Electricity (per unit)	N/A	0.41
Wood		
Car/bakkie (112 kg)	82.8	120
Donkey car (70 kg)	72.5	85
Back bundle (14 kg)	17.8	30
Gas		
4.5 kg	30	51.50
9 kg	35	95
14 kg	55	140
Paraffin		
1/	1.6	5.5
5/	2.5	8.5
Candles (per packet)	3.5	5.5

Social aspects of introducing electricity

The income of the majority of the Paulshoek population falls within the same bracket as the majority of South African households (R400-R799) (Table 7).

Table 7: Comparison of percentage households, from Paulshoek and all of South Africa, falling within each classified monthly income bracket. The South African Statistics are results of the General Household Survey (GHS) conducted in July 2003 by Statistics South Africa (Stats SA 2001). The Paulshoek statistics are results from a questionnaire survey (Appendix 1) of 74 households in the village of Paulshoek in May 2005.

	From each survey: % households within each income bracket					
	R0-R399	**R400 - 799**	**R800 - R1999**	**R1 200 - R1799**	**R1 800 - 2499**	**R2500 - R4999**
Stats SA	25.97	27.57	13.69	7.60	5.91	7.94
Paulshoek	5.4	48.6	9.5	29.7	6.8	0.0

A higher percentage of the UWC have all the appliances listed in Table 8 than the LWC, except for lighting which both classes possess.

Table 8: The percentage of each wealth class which own an electric stove, fridge, freezer, TV or radio/CD player in 2005

Electric appliances	% of household that owns their appliances	
	UWC	LWC
Stove	95	73
Fridge	62	14
Freezer	24	5
TV	70	30
radio/CD player	43	5
Lighting	100	100
'Braaipan'	81	54

Discussion

The introduction of electricity into Paulshoek, in 2003, has dramatically altered the consumption pattern of fuelwood use in all households within the village. Different households have benefited from this transformation according to their wealth class and there has been a change in the social and environmental aspects of the village, relating to the quality of life. This is evident in reduced time spent harvesting, access to media, and a smaller radius of veld affected by fuelwood collection.

Consumption patterns of fuelwood use

Studies done by Archer (1994), Borchers *et al.* (1990) and Mander & Quinn (1995) suggest that the inhabitants of some Namaqualand reserves (Leliefontein, Komaggas, Pella and Richtersveld) who relied solely on fuelwood for their energy requirements, used about 15 kg of fuelwood per day (Solomon, 2000). These findings considered in relation to those of this study indicate a decreasing trend in fuelwood use in the Namaqualand area in the last 15 years. The steep decline of approximately 75% in the last seven years evident in this study is believed to be directly related to the introduction of electricity, three years prior to this study.

The measures of fuelwood used per day (1.7 kg and 6.8 kg) could be an over estimate. In a study by Bhatt & Sachan (2004) they found that the consumption of fuelwood increased by two fold during winter. These studies were conducted during colder months of the year and therefore it would be expected that less wood would be used overall during the year (Solomon, 2000). The majority of households do not own a heater and therefore their only source of warmth during winter months, is fire and consequently the need for fuelwood. Therefore the average estimate of fuelwood use per day in Solomon (2000) and in this study is possibly too high. If a study was conducted throughout the year this value would more than likely decrease. There were also varying weather conditions during the study period. Some days were warm whilst others were cold and rainy. These factors would affect the consumption of fuelwood use. According to Solomon (2000) there is an increase in the amount of fuelwood used, on special occasions such as weddings and funerals. All these factors would need to be accounted for during a continuous study. However, the fact that the data for 1998 and 2005 were recorded at similar times of year improves the strength of comparison between these two studies.

There is, on average, no longer a daily use of fuelwood, it is collected less often and from a closer proximity to the village and the domestic tasks that previously required fuelwood have reduced their necessity. There has been a decline in fuelwood usage for domestic tasks since 1998. Less fuelwood is being used for cooking, boiling water and ironing since 1998. There has been a reduction in the usage of fuelwood for space heating and baking but marginally less compared to cooking, boiling water and ironing. Fuelwood is still being utilised, in most households, for baking once a week, which explains the higher value for this domestic task. The fact that both wealth classes utilise the same amount of both wood species indicates that both classes are still doing baking once a week as the mixed species are used for baking.

The consumption patterns are also related to the frequency of fuelwood collection and use. The distance travelled to collect fuelwood in 2005 has decreased by almost half. The frequency of collections has declined by exactly a third of the previous collection frequency recorded in 1998. Fuelwood is also being used less often within the households. In 1998 the majority of households used fuelwood every day and now in 2005 it has changed to the majority using it once a week. This shift in fuelwood use is very important because on average it accounts to a one-seventh reduction in fuelwood use which also correlates approximately with the decrease in kilogram usage (1, 7 kg down from 6,8 kg).

According to Solomon (2000), the fact that people have to walk long distances and spend more time collecting wood supports the fact that the availability of usable dead fuelwood would decline. This study indicates that people are travelling a shorter distance than during the study done by Solomon (2000). We can therefore infer that more dead wood is available in the veld. However, as long as fuelwood collection continues the immediate area surrounding the village will be relatively highly impacted compared to the entire reserve. According to Solomon (2000), the greatest threat to sustainable fuelwood resource use in Paulshoek, is increased removal of green wood material, removal of below-ground material (i.e. stumps), burning of live trees and removal of shrubs from the vegetation. Solomon suggests that only dead stumps should be removed and used for energy purposes. As indicated above the reduced distances travelled suggest there is more dead wood available in the veld surrounding Paulshoek and as long as inhabitants use dead wood before they harvest green wood the threat to sustainable harvesting is reduced.

Solomon (2000) found that inhabitants use a small range of shrubs for fuelwood purposes. The use of these shrub skeletons has many negative impacts on the environment. These shrubs are important for the growth and survival of seedlings in the vegetation, especially in areas exposed to heavy grazing. Shrub skeletons provide shelter, shade, soil moisture and soil nutrients to seedlings, which recruit underneath them. A study by Du Plessis (1995) showed that between 35%-50% of resident forest bird species in Southern Africa rely on cavities of dead wood either for roosting or breeding or both of these activities. The reduction in fuelwood use will consequently increase the number of shrub skeletons available to protect seedlings, having a positive effect on vegetation growth and other ecological services. The impact of these changes is an increase in vegetation in the areas surrounding the village in response to a shift toward an electricity-dominated society.

To make a simple comparative observation for the use of fuelwood at stock posts, we measured fuelwood consumption at one stock post. Solomon (2000) found that the mean daily fuelwood use at stock posts was 8.8 kg/day. The stock post measured for this study used approximately 8.2 kg/day. Stock posts receive no electricity, have good access to fuelwood resources and depend solely on fuelwood as an energy source. They have therefore continued to use a high amount of fuelwood. There are only 30 stock posts in the Paulshoek area, which covers 20 000km^2. Therefore the impact these stock posts are having is isolated to within a small radius of their stocking post and limited to two or three users. These stock posts will presumably impact the environment at the same level until such time that they receive electricity. However as most stock posts move periodically this impact may be reduced as regeneration is given "recovery time".

Benefits to the community

Solomon (2000) found a significant difference between the number of people in a household and the mean weight of fuelwood used per day. This study found no significant difference between these variables and this could be attributed to the introduction of electricity. The fact that there is no significant difference between the households indicates that an increase in the number of people in a household will not increase the fuelwood use. This is due to the fact that the main use of fuelwood, in most households, is for baking bread once a week. Therefore the number of the people in the house would not affect this weekly event. In certain households the older generation of people still make themselves a small fire every morning. This practice is believed to be traditional. The continued use of fuelwood can be attributed to cultural or traditional perceptions. For example, some individuals may prefer to use fuelwood due to the tradition, or because they feel most comfortable/safe using fuelwood, and so on (An *et al.* 2002). Few questions still remain: will the tradition of baking once a week, continue to occur? Will the tradition of making a fire every morning continue? The new generation of adults living in Paulshoek believe these traditions will fade away (Cloete 2005, pers.

Comm. 24 May). Currently traditions such as making fires and weekly baking have maintained through the introduction of electricity, and therefore will fuelwood use keep decreasing or maintain the level it is currently at in the future?

In order to determine which households have benefited from the introduction of electricity, the number of people still utilising fuelwood was quantified according to wealth class. People's salaries in Paulshoek are not consistent. At certain times of the year, there is work and at others there is nothing. The wealth class does, however, incorporate factors other than income, which helped to place each household into the appropriate class. Solomon (2000) found a significant difference between the amount of fuelwood used (kg) on a daily basis and wealth class, whereas the statistical analyses for this study showed that there is no significant difference between these variables. The use of fuelwood for domestic tasks has decreased more within the UWC than the LWC since 1998. The overall use of fuelwood (kg/day and domestic uses) is less for the UWC than the LWC. This is in keeping with what would be expected; that the LWC would use more fuelwood because they cannot afford alternative energy sources (Borchers *et al.* 1990). However, Solomon (2000) found that UWC households used more wood than the lower income houses. According to Solomon (2000), UWC houses can afford more wood and thus have more wood readily available. Therefore, during colder months, they were consuming a higher amount of wood than the lower income households (Solomon 2000). Alternatively a study by Miah *et al.* (2003) showed that higher income groups had more access to wood from markets but used a lower proportion than the lower income groups. The results from Miah *et al.* (2003) are similar to the findings of this study, the UWC spent more on wood than the lower wealth class but they both utilised the same amount. This difference in results from the studies by Miah *et al.* (2003) and Solomon (2000) is related to electricity supply and quality. The price of wood has increased by the smallest amount relative to the other energy sources used in Paulshoek. As fewer people require a product the price will decrease in order to improve cash inflow. Therefore this small increase in fuelwood price illustrates that the demand for fuelwood has reduced since 1998.

When all the aspects of fuelwood use are considered, it is noted that the UWC has benefited more than the LWC. The LWC utilises more wood because they cannot afford to replace this energy source with electricity, whereas the UWC can reduce fuelwood use and replace it with electricity.

Social aspects of introducing electricity

The switch from a fuelwood-dominated society to a village that incorporates electricity will have affects on the social structure within this society. What drives an energy transition within an area? Leach and Mearns (1988) believe there are two main driving forces: (1) access to dependable supplies of modern fuels in sufficient quantity, and (2) sufficient income to invest in the devices for using them. These two forces are portrayed in the context of Paulshoek. According to a study by Gaunt (2005), electrification in South Africa identifies a concept of electrification for purely social objectives. Proposals for "poverty" tariffs and promises of free electricity illustrate electrification being neither for economic nor socio-economic but for the social objectives of poverty alleviation and political support. A post-programme evaluation of the National Electrification Programme (Borchers *et al.*, 2001) found that electrification in low-income areas was not financially viable, based on a net discount rate of 12%. "The low consumption by newly connected dwellings in the disadvantaged communities poses the biggest threat to the viability of the electrification programme. It is apparent that the electrification programme is uneconomic and unsustainable without cross-subsidisation" (NER 2002). These comments are supported by the statistics from a study by Eberhard (2001): The South African Electricity Supply Industry (ESI) is dominated by a state-owned and virtually integrated utility, Eskom, which ranks seventh in the world in terms of size and electricity sales. It supplies about 96% of South Africa's electricity requirements which is more than half of the electricity generated on the African continent. It currently incurs losses in its sales to rural and residential customers. The total annual cross-subsidy to these categories exceeds R1 billion (Eberhard, 2001). There are clear concerns about the viability of electrification, particularly in rural areas (Gaunt 2005). According to the National Electricity Regulator: "The new challenge in electrification for South Africa in the next couple of years is to address the effective electrification of rural areas in a sustainable manner" (Mkhuwanazi 2001).

Gaunt (2005) points out that very poor households cannot spend much on energy and the appliances needed to benefit from electricity, and may use scavenged wood and other biomass, even when electricity is available. As a result Gaunt believes electrification's benefits of improving health and reducing environmental degradation may not be achieved. By any standard, Paulshoek is poor. And yet several mitigating factors in the demographic and economic make-up of the village make it less so than might appear. Large support in the form of pensions, disability allowances and child support grants provide an underlying safety net for almost a third (29%) of the village households (Rhode *et al.*, 2003). When the estimated annual incomes of inhabitants of Paulshoek are compared to the national annual averages this village is above average. A survey conducted in Paulshoek, 1995, by the Surplus People Project (SPP) found that the average per capita income was R215 per month. This value is below all standard measures of poverty thresholds based on income (Rhode *et al.* 2003) and in international terms it is roughly equivalent to a per capita income of less than $2 per day. In this study, the average monthly per capita income was R382. This value is higher than the international standard of $2 per day. According to this study, there have been improved standards within both wealth classes. A large percentage of the population have access to the media, through electric appliances such as televisions and radios. A stove or 'braaipan' improve cooking standards. 100% of the inhabitants have permanent lighting in their houses, which improves the lifestyle of all the residents. This study shows that since the introduction of electricity in Paulshoek, three years ago, there have been benefits to the surrounding environment (decreased use of fuelwood) and improved living standards through better lighting, cooking, and media access.

In a study by An *et al.* (2002), they portrayed the need for good quality electricity at a decent price. According to these needs, and those forces previously explained (Leach a & Mearns, 1988) the approach by the South African government has contributed largely to the successful switch from fuelwood to electricity in Paulshoek. While both classes have reduced the amount of wood they use, they still currently use the same amount. Use appears to be driven by need in the LWC and desire in the UWC, and in both cases tradition and culture to some extent. The UWC enjoy government subsidization and cost is not a driving factor. While the LWC need government subsidization to afford electricity and do not benefit from this, the cost is still such that they must utilize firewood. If the government continues to subsidize electricity in the rural areas, villages like Paulshoek will continue to receive "cheap" electricity and consequently use less fuelwood than in the past. If, however, the government reduces these subsidies there could be a switch back to fuelwood use.

Since the introduction of electricity in Paulshoek, in 2003, there has been a reduction in fuelwood consumption (kg/day) and inhabitants have reduced the frequency of utilising fuelwood. The UWC has benefited more from the introduction of electricity because they are able to afford to replace fuelwood use with electricity. The LWC however still requires the use of fuelwood. Both classes have however improved their standard of living.

Acknowledgements

I wish to express my sincere appreciation to my supervisor, Timm Hoffman, for all his time, support, patience and constructive suggestions throughout this project. Thank you, Pippin Anderson for your excellent and invaluable advice. This paper is compared to research reported in an MSc thesis by Anastelle Solomon. A special thank you to Elizabeth, for all your hard work with the interviews for this project. To many of the residents in Paulshoek, thank you, for you hospitality and support: namely Voentjie, Leraume, Melvin, Herlus and others. The people in Paulshoek who generously shared their knowledge are deeply thanked and acknowledged. Thank you to all the people from the Institute for Plant Conservation for your invaluable assistance with general enquiries and statistical help: namely Patrick, Peter and Simon. To the Botany department at the University of Cape Town. Thank you to and my honours class for all your support and useful comments. A final thank you to my family, friends and Trevor for your endless support and encouragement.

References

1. Allsopp, N., Visser, D. and M.T. Hoffman 1999. The hydrology and sanitation of Paulshoek, Namaqualand. Unpublished report. National Botanical Institute, Cape Town.
2. An, L., Lupi, F., Liu, J., Linderman, M.A. and J. Huang. 2002. Modeling the choice to switch from fuelwood to electricity, Implications for giant panda habitat conservation. *Ecological Economics*. **42**, 445-457.
3. Arnold, M. and R. Persson. 2003. Reassuring the fuelwood situation in developing countries. International Forestry Review Journal. **5** (4), 379-383.
4. Arnold, M., Kohlin, G., Reidar, P. and G. Shepard. 2003. Fuelwood Revisited: what has changed in the last decade? CIFOR (online), 39. Available from http://www.cifor.cgiar.org./publicaions/pdf_files/op-39.pdf (accessed 19 June 2005).
5. Bembridge, T. J. and J. E. Tarlton. 1990. Woodfuel in Ciskei: A headload study. *South African Forestry Journal*. **154**, 88-95.
6. Bhatt, B.P and M.S. Sachan. 2004. Firewood consumption along an altitudinal gradient in mountain villages of India. *Biomass and Bioenergy*. **27**, 69-75.
7. Borchers, M.L., Archer, F.M. and A.A. Eberhard. 1990. Namaqualand household energy survey. Energy Research Institute. Report no. INT 151. South Africa.
8. Borchers, M., Qase, N., Gaunt, C.T., Mavhungu, J., Winkler, H., Afrane-Okese, Y. and C. Thom. 2001. National Electrification Programme Evaluation, Summary Report. Energy and Development Research Centre, University of Cape Town.
9. Desmet, P.G., and R.M. Cowling. 1999. The climate of the karoo – a functional approach. Pages 3 – 16 in S.J. Milton, and W.R.J. Dean, editors. The Karoo: ecological patterns and processes. Cambridge University Press, Cambridge.

10. DeWees, P.A. 1989. The woodfuel crisis reconsidered: observations on the dynamics of abundance and scarcity. World Development. **17** (8), 1159-1172.

11. Du Plessis, M.A. 1995. The effects of fuelwood removal on the diversity of some cavity-using birds and mammals in South Africa. *Biological Conservation*. **74**, 77-82.

12. Eberhard, A. 2001. Competition and regulation in the electricity supply industry in South Africa. Trade and Industry Policy Strategies: Annual Forum. Misty Hill, Muldersdrift. 10-12 September.

13. Gaunt, C. T., 2005. Meeting electrification's social objectives in South Africa, and implications for developing countries. *Energy Policy*. **33**, 1309-1317.

14. Heltberg, H., Arndt, T.C. and N.U. Sekhar. 2000. Fuelwood consumption and forest degradation: a household model for domestic energy substitution in rural India. Land Economics. 76 (February), 54-67.

15. Hoffman, M.T., Cousins, B., Meyer, T., Peterson, A. and H. Hendricks. 1999. Historical and contemporary land use and the desertification of the karoo. In S.J. Milton, and W.R.J. Dean (eds). The Karoo: ecological patterns and processes. Cambridge University Press, Cambridge.

16. Hoffman, M.T. 2000. Land Degradation in context. Retrieved 21 October 2005, from South African National Botanical Institute: https://www.nbi.ac.za/landdeg Hoffman, T., Todd, S., Ntshona, Z and Turner, S. (eds). 1999. Land Degradation in South Africa.

17. Leach, G. and R. Mearns. 1988. Beyond the woodfuel crisis. People, Land & Trees in Africa. Earthscan Publications Limited. London.

18. Miah, D., Ahmed, R. and M. Belal Uddin. 2003. Biomass fuel use by the rural households in Chittagong region, Bangladesh. *Biomass and Bioenergy*. **24**, 277-283.

19. Mkhwanazi, X. 2001. Chief Executive's Report. In NER: Annual Report 2000/2001. National Electricity Regulator, Sandton.

20. NER. 2002. Electricity Supply Statistics for South Africa. 2001. National Electricity Regulator, Pretoria.

21. Payne, R.J. 1992. The Third world and South Africa, Post Apartheid Challenges. Retrieved October 16, 2005, from http://www.greenwood.com

22. Rhode R., Hoffman, T. M. and N. Allsopp. 2003. Hanging on a wire: A historical and socio-economic study of Paulshoek village. Research report no. 17. Programme for Land and Agrarian Studies.

23. Spalding-Fecher, R. 2005. Health benefits of electrification in developing countries: a quantitative assessment in South Africa. *Energy for Sustainable Development*. **9** (11), 53-61.

24. Solomon, A. M. 2000. *The use and valuation of natural fuelwood resources in Paulshoek, Namaqualand and the ecological impacts on rangeland dynamics*. Thesis (M.Sc.). University of Cape Town.

25. Statistics South Africa, Stats Online "The digital face of Stats SA". 2001. Retrieved 13 June 2005, from http://www.statssa.gov.za/

26. StatSoft Inc. 1984 - 2004. STATISTICA. Version 7. The Netherlands.

27. Todd, S.W. & M.T. Hoffman. 1999. A fence-line contrast reveals effects of heavy grazing on plant diversity and community composition in Namaqualand, South Africa. Plant Ecology, 1-11.

28. World Bank. 1992. World Development Report: 1992: Development and The Environment. Oxford University Press, New York.

Appendix 1

Questionnaire on fuelwood usage in Paulshoek: May-June 2005

I. General

1.

Date:	
Interviewer:	
Interviewee:	
Address (Erf umber):	
Gender:	Age:

2.

Type of house		
Brick	Zinc	Other

Notes (Size in m^2)

....

....

3. What type of transport do you own?

Car	Donkey cart	Other

4. What is your monthly income: ....

II. Fuelwood consumption

5. Have you changed your pattern of wood usage since you received electricity?

Pattern of wood usage	Before electricity	Today (2005)
Daily		
Every second day		
Twice a week		
Once a week		
Every second week		
Once a month		

6. How much wood do you have presently in your house?

Rhus undulata: ....kg Other species: ....kg

What are the other species?

	Species
1	
2	
3	
4	
5	
6	

7. How many people are resident in your house?

Adults:

Children:

Notes (description of house, person, etc. For reference when analysing data):
....
....
....

III. Type of energy source used

8.

- In 1995, what was the main energy source you used?
- In 1995, what did you use each energy source for?
- In 2005, what was the main energy source you used?
- In 1995, what did you use each energy source for?

	Electricity		**Wood**		**Gas**		**Paraffin**		**Candles**		**Other**	
	1998	**2005**	**1998**	**2005**	**1998**	**2005**	**1998**	**2005**	**1998**	**2005**	**1998**	**2005**
Cooking												
Space heating												
Lighting												
Baking												
Boiling water												
Ironing												
Braai												
Other												

9. How do you collect your wood?

Car	**Donkey**	**Walk**	**Don't collect**	**Buy wood**

10. How many times have you collected wood in the last five days?

11. What was the average distance you walked to collect wood?

12. Who collected the wood?

13. How much do you spend on each of the following energy sources in a month?

	1998	**2005**
Electricity		
Wood		
Gas		
Paraffin		
Candles		
Other		

14. Which of the following appliances to you have in your house?

	Electric	Gas
Stove		
Fridge		
Freezer		
Kettle		
Iron		
TV		
CD player		
Heater		
Microwave		
Toaster		
Radio		
Vacuum cleaner		
Braaipan		

15. Have you seen any differences in the veld since you received electricity?

16. What are those changes?

17. How far to you travel for wood, now in 2005?