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Household fuelwood use in small electrified towns of the Makana District, Eastern Cape, South Africa

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Abstract
Access to secure energy supplies is a key foundation for sustainable development. Consequently local planning and development initiatives must be based on a sound knowledge of the energy use patterns and preferences of local users. This paper reports on such for three small urban settlements in the Eastern Cape Province, with a particular focus on fuelwood use. Despite widespread electrification over a decade ago, and perceptions that the ease of fuelwood collection was declining, most households continued to use fuelwood for cooking and space heating, whereas electricity was favoured for lighting. The most common reason for this was because fuelwood was cheap (or free) compared to electricity. Annual demand was approximately 1 450 kg per household per year. Households that collected their own supplies of fuelwood were significantly poorer than those that either bought their stocks, or those that did not use fuelwood at all. Indigenous species were favoured over exotic species, although fuelwood vendors traded mostly in exotic species, particularly Eucalyptus and wattle. The greater reliance of poorer and unelectrified households on fuelwood requires that local authorities consider this in energy planning, otherwise the poor will be neglected in policies such as the Free Basic Electricity.

Keywords: electricity, fuelwood, household attributes, poverty, urban energy mix

Introduction

Access to secure energy supplies is widely acknowledged as a critical foundation for sustainable development. Moreover, access to clean and affordable energy (amongst other things) has been listed as a prerequisite for achievement of the Millennium Development Goals, which concentrate on alleviating world poverty and improving the well-being of poorer sectors of society. As such, the links between energy policies and those addressing poverty are irrefutable (Biggs *et al*. 2004). Fuelwood (either unprocessed or as charcoal) is the dominant energy form throughout the developing world. This is especially so for rural communities, but also for many peri-urban and urban communities (Campbell *et al.* 2003, Brouwer & Falcão 2004).

Despite widespread predictions in the 1970s and early 1980s of an impending energy crisis related to fuelwood shortages, usage has not diminished in many parts of the world (Mahiri & Howorth 2001, Arnold *et al.* 2006). Furthermore, the spectre of extensive environmental degradation caused by growing fuelwood demand has not been realized (Dewees 1989, Sullivan 1999, Nagothu 2001), except where urban demand is significant (e.g. Hosier & Milukas 1992, Luoga *et al.* 2000). Nonetheless, the promotion of electricity as a relatively clean, multipurpose and efficient energy source is seen by many as a solution to most of the concerns around poverty, health and the environment that permeate the fuelwood debates.

Within this understanding, many countries, including the post-apartheid government in South Africa, undertook massive electrification programmes (Howells *et al*. 2006, Bhattacharyya 2006). However, in at least South Africa (Howells *et al*. 2005, Madubansi & Shackleton 2006), Zimbabwe (Marufa *et al*. 1996) and Kenya (Kituyi *et al*. 2001) affordability limited uptake. Consequently, a national policy of monthly Free Basic Electricity (FBE) of 50 kWh per household was introduced just after the turn of the millennium (Howells *et al*. 2006). However, as of 2003 approximately 30% of households in South Africa still did not have access to grid electricity supplies (DME, Draft Free Basic Electricity Policy for SA, June 2004) and hence received no benefit from the FBE. Implementation of the FBE also varies between different municipalities.

Since the introduction of the massive electrification programme and the FBE, there has been limited research to assess how this has impacted the composition of household energy supplies. Moreover, most recent work within South Africa has been in the rural sector (e.g. de Lange & Wentzel 2003, Lloyd *et al*. 2004, Masekoameng *et al*. 2005). This is significant, as the devolution of many government functions to local government requires that individual municipalities have adequate information and understanding of the current situation within their planning domain.

Fuelwood supply and demand is a crucial issue as it spans energy, environmental, health and social aspects, and is often particularly important for the poorer sectors of a community (e.g. Campbell *et al*. 2003, Brouwer & Falcão 2004, Shackleton *et al*. 2006). Within this context, this paper reports on an energy use survey within the Makana Municipality in the Eastern Cape, as part of a broader programme for a Local Environmental Action Programme within the area.

Study area

The study was undertaken in the urban centres of the Makana District Municipality. As a whole, the Makana District is largely agricultural, dominated by cattle and game farms. The mean annual rainfall is approximately 550 – 600 mm. The natural vegetation is shrubby grasslands on the hill tops and dense sub-tropical thicket in the valleys. There are three urban centres in the district; Riebeck East is the smallest (<200 households), Alicedale (± 2 000 households) and Grahamstown, a medium-sized town of approximately 11 000 households.

Grahamstown is the administrative centre of the Makana District. All three towns were electrified between 1992 and 1994, and hence at the time of the survey had been serviced for at least 10 years. Unemployment is high at approximately 50% of the labour source, as are levels of education with 42% of the population having only primary schooling or less (Makana IDP 2005).

Data collected during the course of this study (Table 1) indicate that paralleling the gradient of increasing town size from Riebeck East as the smallest to Grahamstown as the largest, there is a similar trend of increasing wealth indicators (such as mean monthly income, frequency of consumption of meat and monthly expenditure on electricity).

Methods

Between May and August 2004 (winter) a fully randomised interview schedule regarding household energy use was administered to 205 households; 34 in Riebeck East, 61 in Alicedale and 110 in Grahamstown. Households in Grahamstown were restricted to the former township and low income areas in Grahamstown East. Municipal planning maps were obtained for each town, the erf numbers, and a random sample drawn. Data collection included weekends so not to be biased against people possibly being away from work. If nobody was at a randomly drawn designated household, or they declined to be interviewed, we moved to each of the neighbouring households in succession until a successful interview was conducted. Interviews were in the preferred language of the respondent, mainly isiXhosa, then Afrikaans and lastly English.

The interview captured details of energy use in both closed and open ended questions. It included aspects of what they used for lighting, heating and cooking, and their preferences for each of these purposes. If they used fuelwood, additional details were sought pertaining to frequency of use, quantities, sources and unit cost if purchased. For households with a fuelwood pile at the homestead at the time of the interview, they were requested to set aside the amount of wood they typically used within a day, which was subsequently weighed using a spring balance to the nearest 0.5 kg. Lastly, a basic socio-economic profile of the household was captured. Numbers of employed members, and the nature of their job was recorded. Income per household was calculated as the sum of number of State grants received (and value of each which is public knowledge), the income per job type and any other declared cash income from petty trading.

A labouring type job was allocated an income of R600 per month, a policeperson and clerk R3 000 per month, and a teacher R5 000 per month. We recognize that these figures are only approximate, but across the large sample of households, it does serve to differentiate them along a relative scale, and in most instances was reasonably appropriate

Table 1: Selected household characteristics in the three study towns (mean ± SE)

	Riebeck East	*Alicedale*	*Grahamstown*
Mean household size	3.8 ± 0.37 [a]	4.9 ± 0.28 [b]	4.2 ± 0.19 [ab]
Education of hh head (no. yrs)	4.6 ± 0.64 [a]	4.9 ± 0.54 [a]	6.0 ± 0.43 [a]
Mean monthly income (R)	1 076 ± 135 [a]	1 244 ± 90 [a]	1 673 ± 170 [b]
Mean monthly expenditure on electricity (R)	42.8 ± 7.64 [a]	76.7 ± 6.31 [b]	91.0 ± 10.59 [b]
Frequency of consumption of meat (x/month)	3.7 ± 0.62 [a]	6.2 ± 0.78 [a]	6.9 ± 0.76 [b]
Rooms per capita	0.8 ± 0.1 [a]	1.1 ± 0.1 [a]	1.1 ± 0.1 [a]

Note: In comparing towns, unlike superscripts reflect significant differences between towns at least p < 0.05 level) as there were significant correlations between the calculated household income and other indicators of wealth such as frequency of meat consumption ($r = 0.25$; $p<0.05$) and monthly expenditure on electricity ($r = 0.29$; $p< 0.05$).

Data was summarized into spreadsheets and thereafter subjected to statistical analysis. In comparing continuous variables between the three towns, an ANOVA was used if the data was normally distributed, otherwise a Kruskal-Wallis test was executed. If a significant effect was indicated, pairwise comparisons were conducted using the Least Significant Difference. Percentage data were arcsine transformed and subjected to chi-squared tests or 2 x 2 tables as required. Comparison of fire frequency or wood collection between winter and summer was done via a t-test.

Given the anticipated strong peak of fuelwood demand during the cold winter months, use data was recorded separately for winter and summer. Winter was taken to be mid-May to August, inclusive, constituting 15 weeks, and summer was therefore 37 weeks. The unit price of fuelwood in Grahamstown was reported by Shackleton *et al.* (2006) to be R0.41 kg^{-1}. The US dollar: Rand exchange rate during the data collection phase was US$1 = R6.40.

Results

Energy use profile

Electricity was by far the most widespread energy for household lighting, used by over double the proportion of households that used paraffin (Table 2). With respect to space heating there was no consistent pattern between the three towns. Residents of Riebeck East relied largely on fuelwood for space heating, with a few using paraffin. The pattern in Grahamstown was the opposite to this, with 71 % using paraffin and 33% using fuelwood. Alicedale was intermediate between these, with equal proportions using paraffin and fuelwood. In terms of cooking, the patterns were less clear, although paraffin was consistently high in all three towns. Fuelwood was used by more than two-thirds of households in Riebeck East and Alicedale, but by significantly less (approximately half of the households) in Grahamstown. Overall, electricity was the most widely used for lighting, fuelwood for heating and paraffin for cooking.

In examining the positive and negative attributes of fuelwood relative to other energies, the two most frequently mentioned positives were that it was (i) a cheap fuel and was available when cash was scarce so thereby saved them electricity costs and (ii) it provided good heat (Table 3). On the negative side there was little unanimity across the three towns, with the highest response being approximately one-third (35.4%) of respondents in Grahamstown regarding it as smelly and dirty.

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

Purpose	*Town*	*Fuelwood*	*Paraffin*	*Electricity*
Cooking	Riebeck East	76.5 [a]	82.4 [a]	26.5 [a]
	Alicedale	68.9 [a]	80.3 [a]	83.6 [b]
	Gr'town East	50.9 [b]	79.1 [a]	62.7 [c]
	Combined	65.4	80.6	57.6
Heating	Riebeck East	82.4 [a]	14.7 [a]	5.9 [a]
	Alicedale	55.7 [b]	55.7 [b]	8.2 [a]
	Gr'town East	32.7 [c]	70.9 [c]	3.6 [a]
	Combined	56.9	47.1	5.9
Lighting	Riebeck East	0	41.2 [a]	91.2 [a]
	Alicedale	0	47.5 [a]	96.7 [a]
	Gr'town East	1.8	35.5 [a]	77.3 [b]
	Combined	0.6	41.4	88.4

Notes:
• In comparing towns, unlike superscripts reflect significant differences between towns at least p < 0.05 level).
• Gas, dung, dry-cell batteries and crop residues are not included as in all instances except when they were used by less than 5% of households ((other than cooking in Grahamstown (13.9%)). Candles were widely used for lighting.

Table 3: Advantages of fuelwood mentioned by at least 10% or more of respondents in any of the towns

	Riebeck East	*Alicedale*	*Grahamstown*	*Combined*
Free/cheap/saves electricity	35.7	53.5	71.2	53.5
Provides good heat that lasts	50.0	41.9	26.0	39.3
Traditional	7.1	16.3	9.6	11.0
Multipurpose	25.0	11.6	0	12.2
Makes good bread	14.3	4.7	9.6	9.5
Quick	14.3	4.7	0	6.3
It's safer than others	10.7	2.3	0	4.3

Amount of fuelwood used

Although the significant majority of households used fuelwood for cooking and heating this was not on a daily basis. The mean number of fires per household per week in winter (4.0) was three times more than in summer (1.3), significantly so for all three towns ($p<0.001$). A second important use of fuelwood was for cultural rituals (particularly in Grahamstown), in which households gathered family members and offered ritual sacrifices for a number of different reasons, during which fuelwood is needed both for the ritual (often specific species) and for cooking food for the assembled kin. The frequency of rituals was variable between households depending on the degree of their adherence to cul-

Table 4: Annual demand and direct-use value of fuelwood at the three study towns

	Riebeck	*EastAlicedale*	*Grahamstown*	*Combined*
Mass of fuelwood per fire (kg)	11.4 ± 1.49 [a]	15.0 ± 2.34 [a]	13.8 ± 2.24 [a]	13.4
Summer fire frequency (x/wk)	1.4 ± 0.30 [a]	1.2 ± 0.27 [a]	1.3 ± 0.28 [a]	1.3
Winter fire frequency (x/week)	3.7 ± 0.52 [a]	5.0 ± 0.57 [b]	3.3 ± 0.41 [a]	4.0
Annual demand (kg/hh/yr)	1 223	1 791	1 347	1 454

Note: In comparing towns, unlike superscripts reflect significant differences between towns at least p < 0.05 level)

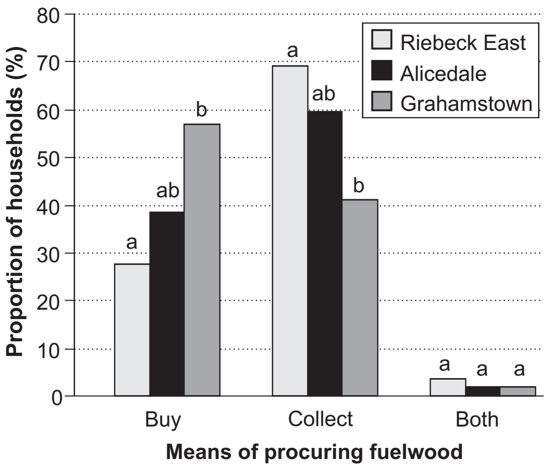
Table 5: Collection frequencies, duration and perceptions of change of ease of collection

Town	*Trip duration (hrs ± SE)*	*Frequency (x/week ± SE)*		*Ease of finding fuelwood relative to 5 – 10 years ago (% of respondents)*		
		Summer	*Winter*	*Harder*	*Unchanged*	*Easier*
Riebeck East	3.1 ± 0.26 [a]	2.0 ± 0.47 [a]	3.4 ± 0.41 [a]	22.7	59.1	18.2
Alicedale	2.2 ± 0.25 [a]	1.0 ± 0.17 [b]	2.7 ± 0.28 [a]	73.3	26.7	0
Grahamstown	4.4 ± 0.32 [b]	1.8 ± 0.34 [a]	3.3 ± 0.44 [a]	52.9	44.1	2.9
Combined	3.2	1.6	3.1			

Notes: In comparing towns, unlike superscripts reflect significant differences between towns at least p < 0.05 level). The large proportion of respondents at Alicedale saying collection had become harder attributed it to the recent development of a luxury resort, golf course and nature reserve, such that they could no longer collect fuelwood in areas that they used to.

tural beliefs, ranging from perhaps three times per year to once every few years. Excluding the use of fuelwood for rituals, the mean mass of fuelwood used per day, when a fire is made, ranged between 11.0 $\pm$ 1.49 kg at Riebeck East to 15.0 $\pm$ 2.34 kg at Alicedale (Table 4). Averaged across the three towns, this equated to 1 454 kg per household per year. With a unit price of 41c kg^{-1}, this equated to R596 direct-use value per year.

The majority of fuelwood users in Riebeck East and Alicedale collected their own supplies, whereas in Grahamstown almost 60 % of the fuelwood users purchased it from local vendors (Figure 1). There was an inverse relationship between self-collection and buying.



Note: In comparing towns, unlike superscripts reflect significant differences between towns at least at the 0.05 significance level.

Figure 1: The proportion of fuelwood-using households mainly buying or collecting their supplies

Collection trips at Grahamstown were longer than at the other two towns (F = 8.6; p< 0.001), with over half the respondents there stating that the ease of collection of fuelwood had declined over the last few years (Table 5). The main reason was expanding housing developments. Collection frequency in summer was significantly lower than in winter (t = 2.6; p<0.05) for all three towns.

The large proportion of respondents at Alicedale saying collection had become harder attributed it to the recent development of a luxury resort, golf course and nature reserve, such that they could no longer collect fuelwood in areas that they used to.

For those collecting their own supplies, two species dominated, namely *Acacia karoo* and *Scutia myrtina* (Table 6). Our direct observations indicate this is more-or-less a reflection of their local dominance in the surrounding environment. In particular, *Acacia karoo* is a pioneer species in the region and readily establishes in disturbed sites and old arable fields. Interestingly, for those purchasing their fuelwood, the primary species were two common alien species, namely *Acacia mearnsii* and *Eucalypus globulus* (Shackleton *et al.* 2006).

Attributes of fuelwood using households

There were a number of wealth-related differences between households who used fuelwood, and those who did not, as well as between those households who collected their own stocks and those households who bought fuelwood (Table 7). In particular, households collecting their own fuelwood were generally poorer, indicated by a number of variables, including lower incomes, smaller houses, lower ownership of electrical stoves, lower expenditure on electricity and a lower frequency of consumption of

Table 6: Fuelwood species preferred and used by at least 10% of respondents

	Species	*Riebeck East*	*Alicedale*	*Grahamstown East*	*Mean*
Preferred species	Acacia karoo	93.1	77.8	75.0	82.0
	Scutia myrtina	27.6		15.9	14.5
	Umqwaru		14.8	11.4	8.7
	Pappea capensis		3.7		1.2
	Eucalyptus sp.		7.4	9.1	5.5
	Olea europaea		3.7	6.8	3.5
	Pteronia incana		3.7		1.2
	Acacia mearnsii		3.7	9.1	4.3
Other species used (by > 10 %)	Scutia myrtina	48.3		18.2	22.2
	Olea europaea	13.8	11.1		8.3
	Rhus lucida	10.3	25.9		12.1
	Clerodendrum glabrum	20.7			6.9
	Umqashi	10.3			3.4
	Mystroxylon heterophylla	13.8	14.8		9.5
	Umqwaru	20.7	14.8		11.8
	Pteronia incanum	13.8			4.6
	Acacia karoo		11.1		3.7
	Pappea capenis		11.1		3.7
	Eucalyptus sp.		18.5		6.2
	Ptaeroxylon obliquum		14.8		4.9

Table 7: Household attributes of non-users of fuelwood, buying households and collecting households

Attribute	**Non-users**	**Buyers**	**Collectors**	**Test statistic**	**P**
Household size	3.9 ± 0.293 [a]	4.6 ± 0.26 [a]	4.5 ± 0.23 [a]	F = 1.9	> 0.05
Education of head (years)	7.0 ± 0.53 [a]	6.0 ± 0.53 [a]	3.8 ± 0.46 [b]	F = 11.0	< 0.0001
Monthly income (R)	1 395 ± 166 [a]	1 926 ± 240 [b]	1 097 ± 76 [a]	F = 7.2	< 0.001
No. of rooms per capita	1.1 ± 0.12 [a]	1.3 ± 0.15 [a]	0.8 ± 0.06 [b]	F = 5.6	< 0.005
% with electricity	87 [a]	95 [b]	79 [a]	$\chi^2 = 4.6$	< 0.05
Of those with electricity, % owning an electrical stove	74 [a]	76 [a]	51 [b]	$\chi^2 = 11.2$	< 0.001
Monthly expenditure on electricity (R)	64 ± 5.27 [a]	96 ± 12.56 [b]	57 ± 6.02 [a]	F = 5.7	< 0.005
No. of times per month consume meat	7.3 ± 1.13 [a]	7.3 ±.95 [a]	4.3 ± 0.50 [b]	F = 4.5	< 0.01

Note: *In comparing use categories, unlike superscripts reflect significant differences between groups at p < 0.05 level or higher.*

meat. The household head also had fewer years of education than either the buyers or non-users.

Discussion

This study corroborates the findings of work elsewhere in Southern Africa that fuelwood is an integral component of the household energy mix, even in urban areas, and even in areas where electricity is available (Campbell *et al*. 2003). A number of factors have been posited as being responsible for this, of which one is that the cost of electrical appliances and the monthly bills for electricity consumed are prohibitive for low-income households (Howells *et al.* 2005). Yet for some, the adherence to fuelwood is because it is regarded as traditional, as mentioned by 11 % of households in this study.

Although electricity has been available for 10 – 12 years within the three study towns, it is clear that uptake at the household level takes time, for a variety of reasons. Consequently, energy planners and municipal developers need to take this into account, ensuring there is an adequate mix of other energy options available, of which fuelwood is a primary one. Whilst there is a growing market for fuelwood in the area (Shackleton *et al*. 2006), the safety-net, or freely available, function is crucial, as it was advocated as the primary reason for using fuelwood by over half the respondents, corroborating the findings of others (e.g. Vermeulen *et al.* 2000, Madubansi & Shackleton 2006).

Consequently, in planning and zoning urban infrastructure well-wooded areas need to be avoided. Where this is not possible, adequate supplementary stocks need to be provided, either in supporting tree planting around homes and vacant lands, or managed woodlots, especially because urban lots are smaller than in rural areas and so the contribution of personal tree holdings to fuelwood supply is much less than is the situation in rural areas. Currently there is no such strategy in South Africa or other countries in the region. The emphasis is on the provision of electricity. As the cost of electricity has been found to limit uptake the government has provided a Free Basic Allowance. Nonetheless this has not, as yet, resulted in a reduction in the prevalence of fuelwood use, and consequently planning at the municipal level must be based on an integrated approach considering a full mix of energy forms, rather than solely electricity (Davis 1998, Brouwer & Falcão 2004).

Indeed, the more detailed analysis comparing collecting households, buying households and non-using households, indicated that it is the poorer households who use fuelwood the most, and are more reliant on self-collected stocks. They had lower monthly incomes and other associated wealth indicators, as well as the least proportion with access to electricity. Of those with electricity, most used it for lighting only, with only half (51 %) owing an electrical stove. The opportunity costs associated with collecting fuelwood can be considerable, in this study ranging from 170 hours per year at Alicedale to 388 hours per year at Riebeck East. This is the equivalent of one full working month at Alicedale and 2.25 full working months at Riebeck East, per household. This is reflected also in the town-scale analysis, which shows the poorest town, Riebeck East, having the greatest proportion of residents still using fuelwood, although it has the highest proportion with electricity.

Although a significant proportion of households used fuelwood, the quantities and frequencies are less than for rural areas in South Africa, where access to other energy forms is more restricted and at a higher price. This is a reflection more of a lower frequency of fires per week rather than lower consumption per fire. For example, most rural households in South and Southern Africa make a fire daily, or perhaps even twice per day (Lloyd *et al.* 2004). Whilst there were some households in our urban sample that made a fire daily, on average it was only 2 – 3 times per week. Consequently the annual demand was in the order of 1 200 – 1 800 kg per household, the equivalent of 320 – 360 kg per person per year. This is approximately half the national average of 650 kg based largely on rural surveys (Shackleton *et al.* 2004).

In this study there was seemingly a strong reliance on a limited number of species, which is at odds to most other work, albeit from rural studies (e.g. Shackleton 1993, Tabuti *et al.* 2003, Pote *et al.* 2006, Madubansi & Shackleton 2007). Indeed, the two most preferred species, *Acacia karoo* and *Scutia myrtina* were ranked considerably higher than others. However, using conventional criteria, the latter species is a rather inadequate fuelwood species, being small in diameter, with strong recurved thorns, and is a favoured fruit species. We postulate that this lack of selectivity is largely a reflection of harvesting taking place along the peri-urban fringe where other disturbances and land transformation have severely depleted the range of species available, as well as the total biomass available. Local fuelwood vendors in the areas generally supply alien species along with *Acacia karoo* (Shackleton *et al.* 2006).

In conclusion, whilst the provision of electricity has numerous benefits, the use of fuelwood remains widespread in electrified urban communities. Consequently, national energy policies and municipal planning processes need to take heed of this and seek mechanisms and opportunities to ensure that an adequate range of energy options are available to urban communities. This is particularly important for the urban poor, and consequently failure to take cognisance of this is potentially most harmful to those households which current national policies profess to have the most at heart.

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