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Fuelwood Demand in the Tamale Metropolitan Area: an Assessment for Sustainable Development Implications.

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Abstract
This paper assessed fuelwood demand in the Tamale Metropolitan area and its implication for sustainable development. The general objective was to use the Travel Cost Method to assess fuelwood demand in the Tamale Metropolitan area. The methodology employed the simple random, stratified random sampling and proportions to determine the individual respondents. The study employed questionnaire to gather data and analyzed the responses using the Ordinary Least Squares method. The field data gathered was used to estimate the aggregate demand for fuelwood in the Tamale Metropolitan area using the travel cost method procedure. The results indicate that as travel cost increases, the number of visits by individual respondents to forested sites for fuelwood decreases. Also, as incomes rise, the number of visits to forested sites by individual respondents for fuelwood falls. It is recommended that, public education on the need to conserve and use natural resources wisely should be embarked upon. A demand management pattern should be adopted to check over exploitation of tree species. Promotion of a balanced use of fuelwood and other fuel alternatives should also be encouraged.
Keywords: fuelwood, sustainable development, travel cost method, Tamale Metropolitan Area

1. Introduction

Fuelwood consumption is one of the main reasons for forest loss in many countries. Globally, harvest of trees for fuelwood was approximated as 54% per annum (Osei, 1993).

In the developing world, biomass is the primary source of energy for domestic use. The most widely used form of biomass is fuelwood, although in areas of scarcity of wood, other biomass forms such as crop residues and dung are used prevalently (Shackleton, 1993).

In Africa, a vast majority of rural households rely extensively upon fuelwood as their basic energy source (Sheya and Mushi, 2000; Brouwer and Falcão, 2004). This according to Madubansi *et al*, 2004 has changed little over the last few decades, despite increasing population pressures and changing socio-economic and environmental profiles.

Most small-scale industries and food-processing enterprises that women in Ghana undertake depend in large part on fuelwood. This dependence on fuelwood has contributed to the growing exploitation of Ghana's forest. It is estimated that, between 1974 and 1990 fuelwood consumption increased by 50 per cent in Ghana (Ardayfio-Schandorf, 1993).

The annual consumption of wood in Ghana was 14 million cubic metres in 2001, equivalent to 10 million tons, and was expected to rise to 20 million cubic metres in 2010 with an average annual growth rate of 4.0% (FAO, 2001).

Estimates by the Savanna Forestry Division (2008) showed that, the Northern Region of Ghana has a land area of 29.5% (70,384km^2) of the total land area of Ghana. The Northern Region of Ghana has 24 forest reserves and these constitute 9.6% of the nation's 266 forest reserves (Savanna Forestry Division, 2008).

The Tamale Metropolitan Area has four forest reserves. These are the Tamale Fuelwood plantation (0.34km^2), Kworgni plantation (0.45km^2), Tamale water works (0.23km^2) and the Sinsablegbini (72.52km^2) near Tugu (Savanna Forestry Division, 2008). These forest reserves are exploited for fuelwood by the inhabitants of the Tamale Metropolitan area.

Sankhayan and Hofstad (2001) have argued that, the widespread demand for fuelwood is linked to a number of environmental problems, including deforestation, biodiversity loss, climate change and land degradation.

About 84.0 % of households in the Northern Region of Ghana use fuelwood as a main source of energy for cooking. 45.1% of households in the Tamale Metropolitan area also rely on fuelwood as their main source of energy for cooking (Ghana Statistical Service, 2000). The increasing pressure to meet both rural and urban demand for fuelwood often results in destruction of tree vegetation.

Fuelwood is a market commodity which has led to increased pressure and accelerated exploitation of all kinds of trees of subsistence, economic or protection value, resulting in serious degradation of the fragile savanna ecosystem and thus threatens sustainability.

Fuelwood is collected in large quantities in an uncontrolled manner in which the impact is felt on fuelwood resources (FAO, 1985).

Sustainable development implies use of natural resources such that the future generations can attain the same

level of well-being as enjoyed by the present generation. It is in context of the need for conservation of the stock of natural resources that sustainable management of forests (SFM) has gained importance. Sustainable Forest Management ensures that values derived from forests meet present day requirements and at the same time the quantity and quality of long term development goals are maintained (Mathur and Sachdeva, 2003).

A major reason for conserving natural resources or keeping the natural capital intact could be the uncertainty about the workings of the ecological systems, the irreversible nature of some natural resources when they are exploited or consumed.

The general objective of the study is to use the travel cost method to assess the demand for fuelwood in the Tamale Metropolitan area.

The specific objectives seek to:

1. examine the factors which influence demand for fuelwood in the Tamale Metropolitan area.
2. use field data to estimate aggregate demand for fuelwood in the Tamale Metropolitan area.
3. evaluate how demand for fuelwood impact on the economic livelihood of the people of the Tamale Metropolitan area.

The hypotheses in this study are:

Hypothesis 1

H_o: the travel cost for fuelwood by individual respondent has no impact on the number of visits for fuelwood in the Tamale Metropolitan area.

H_1: the travel cost for fuelwood by individual respondent has impact on the number of visits for fuelwood in the Tamale Metropolitan area.

Hypothesis 2

H_o: the income of individual respondent has no impact on the number of visits for fuelwood in the Tamale Metropolitan area.

H_1: the income of individual respondent has impact on the number of visits for fuelwood in the Tamale Metropolitan area.

Hypothesis 3

H_o: the educational level of individual respondent has no impact on the number of visits for fuelwood in the Tamale Metropolitan area.

H_1: the educational level of individual respondent has impact on the number of visits for fuelwood in the Tamale Metropolitan area.

Hypothesis 4

H_o: the age of individual respondent has no impact on the number of visits for fuelwood in the Tamale Metropolitan area.

H_1: the age of individual respondent has impact on the number of visits for fuelwood in the Tamale Metropolitan area.

Hypothesis 5

H_o: the travel cost to alternative site by individual respondent has no impact on the number of visits for fuelwood in the Tamale Metropolitan area.

H_1: the travel cost to alternative site by individual respondent has impact on the number of visits for fuelwood in the Tamale Metropolitan area.

In testing the hypothesis regression analysis was used. The expectation is that, these variables postulated above should have a negative relationship with the number of visits for fuelwood for the acceptance of the alternate hypothesis. A positive relationship shows a rejection of the alternate hypothesis and acceptance of the null hypothesis.

2. Methodology

The travel cost method (TCM) is used to estimate economic use values associated with ecosystems or sites that are used for recreation. The method involves using travel costs as a proxy for the price of visiting outdoor recreational sites. The basic premise of this method is that the time and travel cost expenses that people incur to visit a site represent the "price" of access to the site. The TCM is a 'revealed preferences' approach to valuation. If a person travels to a recreation site that can be entered free of charge, then this person values the site at least as much as the cost of getting there. The TCM process is estimated as follows: define the recreation uses and seasons (fuel wood), develop a sampling strategy, specify the model, Measure trip cost, design and implement the survey, decide on the treatment of multiple purpose trips, Estimate the model and calculate access value. The population for this study were users of fuelwood in the Tamale Metropolitan area and it was estimated to be 20407 (Ghana Statistical Service, 2000). The data for this study was obtained from the primary sources. For the primary data, questionnaires were administered to individual users of the fuelwood in each of the sampled houses. A sample size of 392 was used and it was considered enough to explain the behaviour of individuals in

this study area. The reason is that, there are enough similarities in terms of levels of income and educational levels among the elements in the population to explain their behavioural patterns. The study adopted the multiple sampling techniques which include the simple random sampling and stratified random sampling. The stratified random sampling was to avoid merging both rural and urban Tamale for data collection. The main instrument employed in the data collection for the study was questionnaire. A face to face interview was used since other ways of administration of questionnaire like the mail shot and telephone interviews offer several challenges as far as their usage were concerned.

The study adapted the individual travel cost model after Choe et al (1996) on the basis of compatibility with postulates of economic theory, ability to explain observations of the actual world, accuracy of the estimates of the parameters and forecasting ability. In addition, the model provides no room for probability as in the case of random utility models (RUM). This model takes the form:

$$\mathbf{V_i = \alpha_0 + \alpha_1 TC_i + \alpha_2 Y_i + \alpha_3 Edu_i + \alpha_4 Age_i + \alpha_5 Talt_i + \varepsilon_i}$$

Where: $\mathbf{V_i}$ = number of visits for fuelwood by each individual I, $\boldsymbol{\alpha_0}$ = intercept, $\mathbf{TC_i}$ = travel cost for fuelwood by each individual i (expressed in cedis per visit), $\mathbf{Y_i}$ = income of each individual i (expressed in cedis), $\mathbf{Edu_i}$ = education level of each individual i (years), $\mathbf{Age_i}$ = age of each individual i (years), $\mathbf{Talt_i}$ = travel cost to an alternative site by each individual i (expressed in cedis per visit), ε_i = error term, which allows for any other factor that has not being included in the trip generation function, but which is expected not to affect the value of the coefficients. Primary data obtained from the field was edited, all corrections made and coded. After which it was fed into the Statistical Package for Social Sciences (SPSS) version fifteen (15) for processing the primary data.

3. Results

Table 1. below represents responses from respondents on the number of visits for fuelwood. From the Table 1. 32(8.2%) of the respondents visited the site 52 times annually for fuelwood, 34(8.7%) had a visit rate of 104 times annually, 50(12.8%) had an annual number of visits of 156, 97(24.7%) had an annual number of visits of 260 and finally, 179(45.7%) also had an annual number of visits of 364. It can be seen from Table 1. that the numbers of visits were in weekly basis and when each is multiplied by 52 weeks in a year, you will get the annual number of visits.

TABLE 1. FREQUENCY OF VISITS FOR FUELWOOD

Number of visits (Weekly)	Yearly Visits	Frequency	Percent (%)	
1	52	32	8.2	
2	104	34	8.7	
3	156	50	12.8	
5	260	97	24.7	
7	364	179	45.7	
TOTAL	-	**392**	**100**	

Source: Author's Field Work (2011)

TABLE 2. REGRESSION MODEL RESULTS

VARIABLES	PARAMETERVALUES (COEFFICIENTS)	STANDARD ERRORS	t- VALUES
CONSTANT	5.783	0.13	44.393
*TRAVEL COST	-0.334	0.05	-6.734
*INCOME	-0.807	0.016	-51.282
*EDUCATION	0.06	0.017	3.62
AGE	0.015	0.017	0.908
ALTERNATIVE	0.157	0.09	1.753
R^2= 95%	ADJUSTED R^2= 94%	DW= 1.781	

Source: Author's Field Work (2011)

(*) Attached to variables in Table 2 are those which are significant and has the expected sign.

From the Table 2 above, the coefficient of the travel cost variable is (-0.334) which shows that as the individual travel cost increases, the number of visits for fuelwood decreases by 33.4%. For instance, a GH¢10.00 increase in travel cost annually could cause the individual to reduce its visits to for fuelwood by three each year. Similarly, the coefficient of the income variable is (-0.807) signifying that as the individual income increases, the number of visits for fuelwood decreases. The coefficient of the education variable is 0.060 which means a positive relationship with the number of visits for fuelwood. This shows that, those who are educated still prefer to demand fuelwood for their household cooking activities.

Probably, an explanation is that, the educated in the Tamale Metropolitan area derive a desired level of utility

from the demand for fuelwood and would continue no matter their level of education. Empirical literature showed that an individual level of education influence the choice fuel as found by Muyeye (2004).

TABLE 3 TRAVEL COST RESULTS

Average Travel Distance (KM) 1	Frequency 2	Relative Frequency (%) 3	Population 4	Visits Per Year 5	Travel Cost Per Visit (GH ¢) 6	Individual Visitation (Per Year) 7
$\frac{1}{2}$	78	19.9	4,061	13,962	1	3.4
3	209	53.32	10,881	20,273	1.5	1.9
7	81	20.66	4,216	4,050	2	1
10	8	2.04	416	272	2.5	0.7
12	16	4.08	833	512	3	0.6
TOTAL	**392**	**100**	**20,407**	**39,069**		

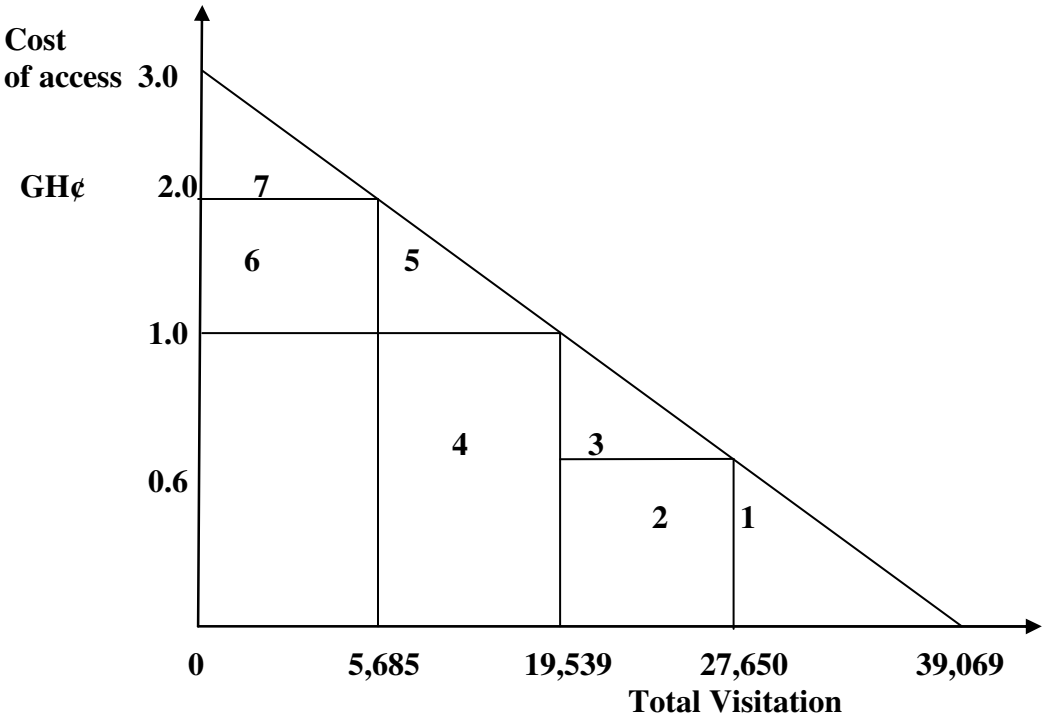
Source: Author's Field Work (2011)

The above Table 3 demonstrates a travel cost result for the demand for fuelwood in the Tamale Metropolitan area. The data indicated that a population of 20,407 households' users of fuelwood made a total of 39,069 numbers of visits for fuelwood each year. The travel cost increases from GH¢1.0 to GH¢3.0 as the distance to the sites increases from half a kilometer to 12 kilometers. The annual visitation rate (individual visitation rate per year) for each distance travelled is calculated by dividing the number of visits from each distance travelled by the population in that distance category.

The result of the study showed that, the frequency with which the respondents (individual visitation) visit for fuelwood is inversely related to the distance from, or travel cost.

From the Figure 1 below, there is a demonstration that travel cost is negatively related to the total visitation for demand for fuelwood in the Tamale Metropolitan area.

Figure 1. DEMAND CURVE FOR FUELWOOD (AGGREGATE)



The area under the demand curve above is the consumer surplus computed from the number of visits for

fuelwood yearly. Mehmet and Mustafa (2006) said that, one could integrate under the demand curve as a way of estimating the consumer surplus. To be able to derive the demand curve, the formula is: Triangle ($\frac{1}{2} base \times height$). This formula is done to arrive at the consumer surplus.

4. Discussion

The findings of the study revealed that, the average annual income range of respondents revealed that, 177(45.2%) had an average income of Gh ¢ 360 per annum, 91(23.2%) had an average income of Gh ¢ 492 per annum, 52(13.3%) had an average income of Gh ¢ 732 per annum, 36(9.2%) had an average income of Gh ¢ 972 per annum, 14(3.6%) had an average income of Gh ¢ 1272 per annum and also 22(5.6%) had an average income of Gh ¢ 1452 per annum. The distance traveled showed that, 78(19.9%) of the respondents travelled half a kilometer for fuelwood, 209(53.3%) had travelled 3 kilometers for fuelwood, 81(20.7%) travelled 7 kilometers for fuelwood, 8(2.0%) also travelled 10 kilometers for fuelwood and lastly, 16(4.1%) had travelled 12 kilometers for fuelwood. The total consumer surplus obtained from the area under the demand curve is GH¢42,877 per year. According to Dupuit (1844), consumer surplus is "the excess of the price which (the consumer) would be willing to pay rather than go without the good, over that which he actually does pay" (Hicks, 1939). The total consumer surplus by the study (GH¢42,877 per year) demonstrated the importance the people in the Tamale Metropolitan area attached to the demand for fuelwood. This is the price they are willing to pay rather than go without fuelwood. The economic significance is that, they are willing to sacrifice work (opportunity cost) for the demand for fuelwood. The price within which the consumer surplus is measured is GH¢2. From Figure 4.10 above, at the price of GH¢2 the quantity of fuelwood consumed is 5,685 and when the price is reduced to GH¢1 the quantity of fuelwood consumed increased to 19,539. This gives a consumer surplus of GH¢3(1+2=3). It is important to stressed that, the consumer would reduce significantly quantity demanded for fuelwood when the cost of access is GH¢3.

However, to ensure the sustainable use of trees for fuelwood, costs of access should be a measure to deter excessive exploitation of trees for fuelwood. As can be seen from the study, an increase in cost of access for fuelwood from GH¢ 0.60P, GH¢1.0 and GH¢2.0 respectively resulted in a decreased in the individual visitation from 27,650, 19,539 and 5,685 respectively. The demand for fuelwood is therefore the various quantities of fuelwood bought at the various costs of access from the above. From the hypotheses tested travel cost, income and education were the major determinants of the demand for fuelwood in the Tamale Metropolitan area.

5. Conclusion and Recommendation

This research work was conducted using the travel cost method as a tool to assess the demand for fuelwood in the Tamale Metropolitan area which is seen as the general objective of the study. The specific objectives of the study were to examine the factors that influence the demand for fuelwood in the Tamale Metropolitan area, use field data to estimate aggregate demand for fuelwood in the Tamale metropolitan area and evaluate how demand for fuelwood impact on the economic livelihood of the people of the Tamale Metropolitan area.

The findings showed that increases in the travel cost for fuelwood results in a decrease in the number of visits for fuelwood. This negative relationship showed that, individuals are very mindful about the expenditure they incur on fuelwood. This ensures that, the number of visits for fuelwood reduces and thus reduces the amount of fuelwood exploitation. The income level also showed a negative relationship with the number of visit for fuelwood. The implication is that, as income level rises, (following the prediction of the 'energy ladder' model) individuals substitute fuelwood for other forms of fuel. This lessens the exploitation of the forest and hence, ensures trees are harvested sustainably. However, the individual education level had a positive relationship with number of visits for fuelwood. This signifies that, those who are educated in this area see fuelwood as providing them a given level of utility. The age and travel cost to alternative sites were insignificant. The major determinants of demand for fuelwood in the Tamale Metropolitan area are travel cost, income and education.

The results of the study have provided a concrete conclusion that may be drawn as regards the demand for fuelwood in the Tamale Metropolitan area.

With regard to the importance of fuelwood to the people, many of the individual respondents have considered the demand for fuelwood as a safety net that serves to reduce their livelihood vulnerability. This is because, fuelwood is a source of trade to the people as they do not pay to harvest the resource except the cost of access. This serves to alleviate the poverty that perpetuates the society and hence, the demand for fuelwood is seen to be very important.

The people in this area have not complied with a mere call that once you cut a tree, you plant one to safeguard the environment. This issue broadly embraced sustainable use of forest resources which has not received considerable attention. Sustainable use of forest resources in the case of demand for fuelwood in the Tamale Metropolitan area is really under serious attack and this may be widely attributable to lack of education on

environmental issues or ignorance.

In the light of the results obtained and the conclusion drawn, the following recommendations are made to the government, international development organization, users of fuelwood in the area, non-governmental organizations and policymakers and future researchers.

The government needs to embark on public education about the dangers associated with excessive demand for fuelwood- the environment and future generations. If the government is able to articulate its views well, the people may see reason.

Secondly, non-governmental organizations could help introduce interventions like providing other job opportunities for the people who could have enough money to go in for other fuel alternative like L.P. Gas and energy saving stoves. In addition, government could make this L.P. Gas more cheaply by subsidizing the product. The government could adopt fuel saving stoves which are piloted by new energy and other non-governmental organization. Finally, laws could be enacted and strictly enforced for compliance to safeguard the environment.

The international development organization responsible for green revolution could assist by proving funding either to help alleviate the poverty situation in the area and also assist in afforestation programmes. To the users of fuelwood in this area, a conscious effort should be made to combine the use of fuelwood with other fuelwood alternatives like gas to complement each other. Hence, the dependence rate on fuelwood could reduce to ensure sustainable use of forest resources.

Lastly, experience has shown that, fuel wood is more of traditional and cultural practices and to ensure sustainable development, communities must be involved actively regarding and decision as to harvesting and usage. To future researchers who might be studying on similar issue in the study area, this research is not exhaustive and it only laid a foundation on the assessment of the demand for fuelwood and in the Tamale.

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