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Moving from Charcoal Use to Alternative Sources of Energy in Dar es Salaam, Tanzania

Emmanuel Patroba Mhache*

Abstract

Reducing pressure on forest resources by promoting alternative sources of energy may significantly protect the environment and attract healthy ecosystems. This paper investigated the manner in which charcoal users can switch to alternative sources of energy in Tanzania. It draws data from a study that was conducted in Dar es Salaam region, where the use of charcoal is widely pronounced.The paper involved 108 respondents; including heads of households, officials, and charcoal users. Questionnaires, interviews, observation tools and documentary review methods were employed in data collection. Quantitative data were analysed using SPSS version 20, while qualitative data were analysed using content analysis. The results suggest that about 75.9% and 14.8% of the respondents depended on charcoal and gas, respectively. The low prices of charcoal and peoples' perceptions on charcoal are the main reasons influencing the overdependence on charcoal. Availability, reliability and affordability of charcoal are the main reasons why people are not ready to abandon charcoal and shift to alternative energy sources.The paper recommends that urban dwellers be encouraged to use alternative energy sources such as gas and electricity. Subsidizing prices/ tariffs of alternative energy sources may encourage the use of alternative energy sources. Adoption of the use of efficient and energy saving stoves may also reduce dependence on charcoal. This can be done in different ways such as providing energy saving stoves to people for free or at subsidized prices. Thus, the government, NGOs, environmental stakeholders, and others should finance energy saving stoves.

Keywords:*alternative energy sources, charcoal, Dar es Salaam, fuel-wood, charcoal use*

1. Introduction

Wood energy dominates source of energy in Sub-Saharan Africa and Tanzania in particular (African Development Bank Group, 2015; Ishengoma, 2015). Tanzania's households depend primarily on woodfuel as the main source of energy (Mnzava, 1981, 1991;Lusambo, 2016; Msuya et al., 2011; Lusambo, 2016). Thus, woodfuel is used for cooking, heating, warming and lighting in Tanzania (Heltberg, 2003).

*Department of Geography, Open University of Tanzania, Dar es Salaam, Tanzania: ngorora@yahoo.com; emmanuel.mhache@out.ac.tz

Differences in fuel sources used can be noted across different landscapes and socio-economic divides. Firewood is used in rural areas, while charcoal is preferred in urban areas (Mhache, 2012; Lusambo, 2016).Fuel is an essential source needed for the household to survive. Households in Tanzania generally use a combination of energy sources for cooking that can be categorized as traditional (agricultural residues and fuel-wood), intermediate (charcoal and kerosene), or modern (liquefied petroleum gas (LPG), biogas, and electricity) (Msuyaet al., 2011).

The major sources of energy in the country are firewood, charcoal, kerosene, electricity and gases. The uses of these energy sources vary between rural and urban areas;thus, some energy sources dominate in one area compared to other areas. Woodfuel (firewood and charcoal) are the major energy sources used by the majority of Tanzanians in both urban and rural areas (Hosier, 1993 in Malimbwi and Zahabu, 2005).Electricity is mainly used for lighting and small appliances like radio, televisions and phone charging rather than cooking, and represents a small share of total household consumption in energy terms (Kilahma, 2005). Over one million tons of charcoal is used for cooking annually in Tanzania's urban areas, which is equivalent to 109,500ha of forest loss (TATEDO, 2009). The increasing tendency to use charcoal instead of electricity or LPG is driven by the availability of charcoal and its low price (ibid.).

Charcoal is preferred in towns/urban areas because it is cheap, easy to transport, distribute and store (Kilahama, 2005; Lusambo, 2016). Charcoal used in urban areas is supplemented by other sources of energy like kerosene, electricity, and gas (Mwandosya et al., 1997; Mhache, 2012). It is obvious that, households use more than one energy sources. Apart from being a source of energy, charcoal is also used as source of cash income for households through its sale (Zulu & Richardson, 2013). The extraction of forest resources for charcoal has been stimulated by the presence of reliable markets in urban centres, such as Dar es Salaam. Generally, charcoal is produced in rural areas where it is not used, and transported to, and consumed in, urban areas where it is not produced (Malimbwi & Zahabu, 2005; Kilahama, 2005; Mhache, 2012). This is so because most of urban dwellers in large cities like Dar es Salaam cannot afford alternative sources of energy like kerosene, electricity and gases for all their activities due to the fact that their prices/costs are high compared to charcoal (Lokina & Mapunda, 2015). Also, charcoal is highly demanded in urban areas because it is a relatively cleaner and less costly and readily available source of energy all the time of the year (Zulu & Richardson, 2013).

As mentioned earlier, the main source of fuel in both urban and rural areas within developing countries like Tanzania is biomass (FAO, 2012; Ishengoma, 2015).Biomass in the country is available in two forms: charcoal and firewood.Charcoal is energy that is made from wood, while fuelwood is collected

and used directly from the field (FAO, 2012). Fuelwood gathered from forested areas is the most important source of domestic energy for the developing world (Heltberg et al., 2000).It is estimated that 60-85% of Africans use fuelwood as their primary source of fuel (FAO, 2009).However, in Tanzania, 90% of the total energy consumption (biomass, petroleum, electricity, coal) is fuelwood (SADC, 1993; NBS, 2013).The use of charcoal in many countries as a source of energy has resulted into a number of health and environmental problems. Health problems associated with charcoal use include blindness, red-eyes, coughing and TB; while environmental problems include deforestation, land degradation, air pollution, and others. These problems have engineered the need for society to move to alternative energy sources.

In Tanzania, like many other developing countries, biomass fuel dominates as a source of energy (Ishengoma, 2015). It is estimated that 95% of the people in Tanzania depend solely on charcoal and firewood as a source of energy (Lusambo, 2016). According to Ishengoma (2015), biomass accounts for about 90% of the total national energy consumption, with 2% from electricity and 8% from petroleum products. The price of charcoal is cheaper than alternative energy sources; and as a result, it is difficult to stop the use of charcoal. Also, the lack of appropriate mechanisms -- including adequate infrastructure -- to allow households in urban areas afford and use alternative sources of energy leaves them with charcoal as the main household source of energy for cooking and heating.

For the past 40 years, Tanzanians have experienced a risein the prices of kerosene, liquid petroleum gas (LPG), and electricity, while real income of many people is declining (Ishengoma, 2015; Lusambo, 2016). This situation has discouraged urban residents to move to alternative energy sources. However, although there are various different alternative energy sources in Dar es Salaam region, still the reasons for people relying on charcoal use is not known. This paper, therefore, examines the possibility of urban dwellers to switch from charcoal to alternative energy sources in Dar es Salaam region,and challenges hindering that shift.

2. Context and Methods

2.1 *Study Area*

The paper employs data collected from four wards in the city of Dar es Salaam: Manzese, Tandika, Kibamba, and Pugu. These were purposively selected due to a large part of their population using charcoal (NBS, 2013).

2.2 Sample Size

A total of 108 heads of households were selected randomly, and involved in structured and semi-structured interviews. In each ward, a list of heads of households was obtained from the ward executive officer, where a table of

random numbers was used to select 27 samples from each ward. Since the major reason of this paper was to examine the possibility of moving away from charcoal, any resident appeared to be a potential respondent, provided that s/he was over 18 years.

2.3 Data Collection

Heads of households using charcoal, gas, electricity, kerosene and firewood were involved in the interviews. Charcoal users explained why they preferred charcoal, while non-charcoal users explained why they opted for alternative sources of energy. Four focus group discussions were held in the four wards with 20 key-informants to complement interview data.Key informants were charcoal vendors, and 4wards executive officers. In addition, there were four focus group discussions with 8 individuals from categories of charcoal sellers, users, and non-users of charcoal. Primary data depicting the types and quantities of energy sources used by the households were also collected. To supplement primary data, secondary data were gathered from various sources such as journals, books, reports, and from published and unpublished materials.

2.4 Data Analysis

Statistical Package for Social Sciences (SPSS), Ms Excel and content analysis were used for data analysis. The paper employed descriptive statistics to analyse data. Descriptive statistics such as mean, percentages and frequencies were used to assess households' energy sources and use, and to provide insights into different socio-economic characteristics of the households. The results of the analysis are presented in the form of tables, figures, and in narratives.

3. Results

This section presents the results that serves as a basis for this paper. It starts with providing demographic and socio-economic characteristics of the respondents. It further presents the possibility of urban dwellers switching from charcoal use to alternative energy sources in Dar es Salaam region,and challenges hindering that shift.

3.1 Socio-Demographic Characteristics of Respondents

The findings revealed that about 57.4% of the respondents were males, and 42.6% were females (Table 1).The age of the respondents ranged between 20 and 70 years. The majority of the respondents (38.9%) were in the aged group of 30 to 39 years. About 31.5% were of the age between 40-49 years, while 15.7% were aged 18-29 years; 13% were aged 50+ years. The mean of the years was 40.01; and the standard deviation was 10.78. Also, a majority of the respondents were married (73.1%), while 25% were single. The others were separated and widows. Respondents were of different level of education ranging from informal to university level education:a majority of the

respondents (71.3%) had university education, 22.2% had college education, while 3.7% had secondary education. Only 1.9% and 0.9% of the respondents had primary and informal education (had not gone to school), respectively.

Table 1: Socio-demographic Characteristics of the Respondents

Variables	Frequencies	Percentages
Gender		
Male	62	57.4
Female	46	42.6
Age		
18-29	17	15.7
30-39	43	39.8
40-49	34	31.5
50+	14	13.0
Marital status		
Single	27	25.0
Married	79	73.1
Separated	1	0.9
Widow	1	0.9
Education level		
University education level	77	71.3
College level education	24	22.2
Secondary education level	4	3.7
Primary education level	2	1.9
Informal education	1	0.9
Household size		
1-2	17	15.7
3-5	59	54.6
6-10	28	25.9
11+	4	3.7
Occupation		
Civil servants (government employees)	66	59.5
Private employees	8	7.2
Farming	7	6.3
Business	6	5.4
Other occupations	24	21.6

Source: Field data, 2019

The household size of the 108 people interviewed ranged from 1 to 12 members, with an average of 5 persons per household (Table 1). This average size of 5 is relatively normal as per Croon (1984 in Mhache, 2012) who puts a typical household size for an area at 5-6 members. Many of the respondents (54.6%) had a family size of 3-5 members, while 25.9% of the respondents had a big family size of 6-10 members. However, 15.7% and 3.7% of the respondents had

1-2 and 11+ members of family, respectively. Household size was of importance because it reflects or determines the amount of energy and sources of energy used in the household for cooking and heating:the bigger the household size, the more the energy is required in terms of firewood and charcoal, or other energy sources, for cooking and heating.

The main sources of income of the respondents were crop farming, petty business, civil or private employment; and others engaged in livestock keeping, tailoring, and carpentry (Table 1). The findings showed that 59.5% of the respondents were civil servants, i.e., employees of the government. About 7.2%, 6.3% and 5.4% of the respondents were privately employed, farmers, and petty business, respectively. The category for other occupation had 21.6% of the respondents. In this category,the respondents' occupations were carpentry, masonry, tailoring and livestock keeping. Occupations determined income and type of energy used, andalthough it is not that all people with high income use or adopt alternative energy sources, a large part of them do. In this regard, most government employees were able to use alternative energy sources (gas, electricity and kerosene) than those privately employed.

3.2 Sources of Energy in Urban Areas

Thefindings revealed the different sources of energy used in Dar es Salaam as shown in Table 2. The energy used was determined by the type of food cooked, time available/used for cooking, and the price of the energy source. Sources of energy identified in the study were charcoal, firewood, gas, and electricity. Others were kerosene and timber dust. About 75.9% of the respondents preferred charcoal than other sources of energy, 14.8% liked using gas, while 5.6% preferred firewood. Others preferred electricity, kerosene, and timber dust as presented in the Table 2.

Table 2: Fuels Used in Urban Areas

Most Energy Used	Frequencies	Percentages
Charcoal	82	75.9
Gas	16	14.8
Firewood	6	5.6
Electricity	2	1.9
Kerosene	1	0.9
Timber dust	1	0.9
Total	**108**	**100.0**

Source: Field data, 2019

It was further noted that families used more than one source of energy. Table 3 summarizes energy combinations used by the people interviewed. It was revealed that 13.9% of the respondents used a combination of charcoal, electricity, kerosene and gas; while 13% used gas, kerosene, timber-dust and

gas for energy. Results also showed that 9.2% of the people interviewed used a combination of charcoal, electricity and kerosene; while 4.2% preferred charcoal, firewood, and gas. Note that electricity and kerosene were mainly used for lighting and for boiling water, boiling tea, and heating food. Other combinations of energy used in the study area are as presented in Table 3.

Table 3: Combination of Energy Sources at Family Level

Combination of energy	Responses	Percentages
Charcoal, electricity, kerosene and gas	15	13.9
Gas, kerosene, timber-dust and gas	14	13.0
Charcoal, electricity, kerosene	10	9.2
Charcoal, firewood, gas	5	4.6
Charcoal, firewood, kerosene	3	2.8
Electricity only	3	2.8
Electricity and gas	28	25.9
Charcoal, electricity and timber dust	6	5.6
Crop residues, gas, electricity and charcoal	9	8.3
Cow-dug, firewood, kerosene, electricity and gas	15	13.9
Total	**108**	**100.0**

Source: Field data, 2019

3.3 Moving Away from Charcoal Use

Charcoal selling is a livelihood strategy of some people in many urban areas in Tanzania. The business has been in operation for many years. The strategy must be sought to provide charcoal sellers with other living options, otherwise the charcoal business and charcoal use will not cease. If charcoal is not available in urban areas, it does not mean that people will not eat cooked food; they will be forced to use other available alternative energy sources. Thus, the first thing to do in curbing the use of charcoal is to prevent it from entering in urban areas, and making alternative energy sources available. The second step is to increase restrictions-- including imposing high taxes on charcoal -- and prohibiting charcoal-making in rural areas, the main source of charcoal. In addition to the foregoing, the data collected in the field proposed a number of measures which can enable charcoal user to shift to alternative energy sources (Table 4).

Table 4: Reduced Charcoal Use and Use Alternative Energy Sources

Reasons	Frequencies (n=108)	Percentages
Reduce prices of gas and electricity	97	89.8
Change peoples' perceptions	80	74.1
Reduce taxes on gas and electricity	77	71.3
Use of efficient cooking stoves	71	65.7
Educate the society on the use of alternative energy	63	58.3
Increase taxes and prices of charcoal	51	47.2

Source: Field data, 2019

One way of reducing charcoal-use is the use of efficient cooking stoves as said by 65.7% of the respondents (Table 4). Efficient cooking stoves use less charcoal or less firewood. Small piece of wood can be used for longer time than using the normal stoves. A man interviewed in Tandika said: "*Before using efficient cooking stoves, I was using 20kg of charcoal per week, now I am using 11kg. After shifting to efficient cooking stoves, I have reduced charcoal use almostby half.*" Also, a woman interviewed in Manzese Ward said: "*Open stoves use a lot of charcoal because a lot of heat is lost dueto the kind of stove, which is open and does not save heat as efficient stoves do.*" The last woman interrogated had this to say, "*Most families prefer three stones cooking, this kind of open fire does not contain or control the fire: a lot of heat is lost.The government should provide efficient cooking stove for free.*"

The findings show that 89.8% of the respondents were of the opinion that there is a need to reduce the prices of the alternative sources of energy such as kerosene, electricity, and gas. This can be done by subsidizing theircosts. Reducing the price of alternative source of energy will encourage many people to use alternative energy sources. Different ways can be used to reduce prices of alternative energy sources such as by giving subsidy, reducing taxes, or reducing tariffs on these sources. The argument here is that the price of alternative energy sources should be reduced. This argument was supported by 89.8% of the 108 heads of households interviewed (Table 4).

The provision of education to the society on the negative impacts of using charcoal is another way of reducing/stopping the uses of charcoal. This was supported by 58.3% of the participants:that people should be educated on the benefits of using alternative energy sources (Table 4). One way of doing this, for example, is by computing prices of using charcoal and comparing them with the use of other energy sources: one will find that there is no difference in terms of cost. A primary school teacher in Sinza Ward said: "*Charcoal is expensive than gas and electricity. I used gas (Oryx) of TZS49,000 for two weeks, but I used charcoal of TZS50,000 for the same days, the difference is only TZS1000. Note that lighting gas takes few minutes than charcoal: here you have saved time and health.*" Education on the use of alternative energy sources is missing for many people.

The role of government on the shift of society toalternative source of energy isinevitable. It has theduty of influencing people to reduce or abandon the use of charcoal, and switch to alternative energy source. The government should subsidize energy sources by reducing their taxes, as advanced by 71.3% of the study participants. Most Tanzanians expected that the discovery of gas in Mtwara would reduce electricity tariffs but this did not happen: the tariffsare still high. Also, the government should support the production of alternative energy sources, which will encourage people to shift from charcoal use to other

energy sources. Similarly, there is a need to enforcement rules, laws and regulations to protect forest products as sourcesof energy. This can be done by increasing taxes on charcoal to discourage people from using it and shifting to alternative energy sources.

If due emphasis is given on other energy sources -- such as wind energy, bio-gas, and solar energy – this will reduce the dependence on charcoal. One man interviewed in Mbagala had this to say: "*Buying panels for solar power is expensive it goes up to TZS1m: but once bought, it lasts long.*" Also, a women interviewed in Ilala Boma, who was using bio-gas, said: "*I have used biogas for 5 years now, it costs me TZS5m to instal the bio-gas system.Since thenI have been using it; it ischeap to maintain, use and repair.*"

Moreover, there is a need of sensitizing people to use and opt for alternative energy sources, especially on the problems associated by the use of forest products as sources of energy. The government should increase its campaigns in educating people on the negative environmental effects resulting from using charcoal/ firewood. There is a need to create awareness among the people not only consider short-term benefits, but also long-term benefits to be gained in the future by using alternative energy sources and saving forests.

However, the study found that there is still a lot of controversy in theuse of alternative energy sources in some areas. For example, somepeople had the view that food cooked using charcoal taste differently (i.e., more delicious) from food cooked using other energy sources, as argued by a woman in Ubungo: "*Rice cooked with charcoal is delicious than the rice cooked using gas and electricity.*" Another woman in Kinondoni lamented: "*Banana cooked using charcoal smell smoky and taste well than food cooked using kerosene, because it is possible for the food cooked with kerosene to smell of kerosene.*"

4. Discussion of the Findings

This study has demonstrated that it is not simple to stop charcoal use in urban areas. Table 2 showed that 75.9% of the respondents use charcoal for cooking. The study by Kilahama (1983/2005) showed that the majority of the households on Mainland Tanzania are heavily dependent on charcoal as a source of energy to cook food and perform other households' activities.It is the important energy source in Tanzania, and in Dar es Salaam City in particular, as it is cheap, reliable, and readily available to the majority (Malimbwi et al., 2004).

However, the price of charcoal do not reflect its real cost. If the real cost of charcoal use is computed, people will realise that it is not that cheap, and automatically shift to alternative energy sources.

Charcoal energy is ranked as the first energy source in Dar es Salaam region. This finding is similar to that of Kilahama (2005), who ranked charcoal as the highly used source of energy in urban areas than any other. The availability of charcoal and its price is among the reasons encouraging people to rely on it. It was further discovered that socio-economic factors affect the consumption of charcoal in urban area in the study area since income and perceptions determine energy sources to use. As charcoal is mainly consumed by urban households; increased urbanization implies increased charcoal consumption (Ishengoma, 2015).

Tanzania is blessed with abundant energy in different forms:wave energy, bio-fuels, natural gas, geothermal power, wind energy, biomass energy, and tidal energy. If all these energy sources are developed and made available, they would reduce the dependence on the use of charcoal. This will enable some people to stop completely from using charcoal, while others could reduce the use of charcoal.The study results by Lokina and Mapunda (2015) showed that households with maximum level of education beyond primary schoollevel are more willing to switch to alternative fuels compared to those who whosemaximum education is below primary schools. Thus, people with education above primary education level are well-informed on the adverse effects of charcoal on the environment and human health. If given easier and cheaper form of energy, these could switch from forest sources.

It is estimated that 60% of all wood taken from forests globally is burnt as fuel, either directly or by first converting it into charcoal. To enable communities move away from charcoal, a lot still has to be done. The country has to effectively educate its people on the advantages of stopping using charcoal and shift to other sources of energy. This study affirms that the cost of using charcoal and alternative energy sources like gas and electricity does not vary much in terms of costs.This is evident in Table 2 that 14.8% of the respondents used gas while 75.9% used charcoal. Electricity was used by 1.9% of the respondents. With this note, there is a big possibility of people shifting to alternative energy sources as the findings proved.

5. Conclusions and Recommendations

From the analysis, the study concludes that moving away from charcoal use to alternative source of energy in Tanzania is possible through instituting strict measures on charcoal-making, transportation, and selling it in urban areas. There are a lot of alternative energy sources in Tanzania that can be used to stop people and enable them reduce the use of charcoal. People should be educated and assisted to abandon charcoal use and shift to alternative energy sources as their efficient, time-saving,safe and healthy sources of energy.

Among others this study recommends the following:

- Urban dwellers should be encouraged to use alternative energy if the price is reduced and alternative energy sources are available throughout the year.
- Education should be given to people on the benefits of using alternative energy sources and disadvantages of using charcoal. There is no big difference between the cost of using charcoal and other energy sources.
- Promote adoption of the use of efficient and energy saving stoves. This can be done in different ways such as providing energy saving stoves to people for free. The government, NGOs, environmental stakeholders, and others should finance energy saving stoves.
- Since it is a gradual process of people shifting from charcoal to alternative energy sources, people should be encouraged to promote agro-forestry and establish tree plantation to produce charcoal sustainably, instead of solely relying on natural forests.
- All Tanzanian should be encouraged to engage in tree-planting and afforestation so as to regeneratetrees that have been cut for charcoal-making.

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