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Dynamics of Household Energy and Cooking Stoves in Maroua, Far North Region of Cameroon

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Authors' contributions

This work was carried out in collaboration between all authors. Author VCT designed the study, wrote the manuscript. Authors MI and TI supervised, read and approved the final manuscript.

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ABSTRACT

Most developing countries depend on solid biomass for household cooking energy with daunting problems to the inhabitants and the environment. This is the case in Maroua where dwindling fuel wood supply has resulted to energy scarcity in residential households pushing them into hardship, untold sufferings, and rampant deforestation. The goal of this study was to critically examine the sources of household cooking energy, analyze the new energy efficient stoves technology introduced as a suitable alternative and make recommendations. Three hundred structured household questionnaires were administered to some groups representative of the population. Some formal semi-structured interviews were administered to some stake holders in this domain. The data was analyzed using the SPSS. Systematic sampling technique and ethnographic observations revealed that the most frequently used household energy sources are wood and charcoal, though 80% of households use more than one source. Because of the plight of these traditional energy sources, a switch to more energy efficient stoves as a suitable alternative is on-going. The study revealed that socio-cultural factors seriously affect the adoption of energy efficient

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technologies placed at the disposal of the villagers in the Far North Region of Cameroon. By analyzing the situation, the paper makes recommendations which when adopted will help resolve the household energy crisis.

Keywords: Biomass; energy efficient stoves; energy; scarcity; deforestation; climate change; Maroua; Cameroon.

1. INTRODUCTION

Access to safe, efficient and reliable energy sources is a key ingredient for development but since the 70s, the world has been experiencing continuous increase in the prices of energy products leading to a major setback in the socio-economic and environmental development of both rural and urban populations. As a result, the welfare of around 2.5 billion people worldwide is continuously challenged by the dependence on inefficient biomass fuels for their daily cooking energy needs. According to [1], as of 2011, about 1.26 billion people do not have access to electricity and 2.64 billion people rely on traditional biomass (fuelwood, charcoal, dung and agricultural residues) for cooking mainly in rural areas in developing countries [2]. Under a baseline scenario, [2] projects that the number of people without clean cooking facilities could remain almost unchanged in 2030. Household cooking consumes more energy than any other end-use services in low-income developing countries [3,4].

The situation is more severe in Sub-Saharan Africa (SSA) where 76% of the region's population makes use of biomass fuels as their primary source of energy [5,6,3]. In Sub Saharan Africa (including Cameroon and Maroua), the most prevalent household energy source used for cooking and heating is fuel wood in the form of firewood and charcoal.

More than 80% of Cameroonian households use wood fuel as their main source of energy for cooking and heating [7] This leads to the irrational exploitation of the forest resources resulting to deforestation and soil degradation. This situation is more severe in the Northern Region of Cameroon which is suffering from the encroachment of the desert [8]. In the Far North Region 85% of households use wood fuel for cooking [9,10] and this brings the demand for fuel wood in Maroua town to about 350 tons per day and 128,100 tons per annum [5,11]. The demand for wood fuel is superior to the supply and projections have announced serious progtressive deficits due to deforestation [10]. The [12] estimated it at 0.6% per annum. Schaffner [9] estimates that he total demand for wood fuel by households and micro enterprises was 1.5 million of m^3 per annum for the region and can be explained by increasing population and also due to the non-adoption of other efficient wood stove alternatives.

Maroua is situated in the Diamaré Division, Far North Region with a population of 400,000 inhabitants distributed within 3 council areas: Maroua 1, Maroua 2 and Maroua 3 (Fig. 1).

1.1 The Problem

Wood fuel is the major source of energy for most rural and urban population including low-income people in Cameroon but the potential supply of wood fuel is dwindling rapidly leading to scarcity of energy and environmental degradation [11]. The majority of the Cameroonian population is faced with the real energy crisis, that is, the daily scramble to obtain wood fuel to meet domestic use. Current studies on wood fuel supply in developing countries have concluded that wood fuel scarcities are real and will continue to exist, unless appropriate approaches to resource management are undertaken [9].

According to [13], 3% of the global burden of disease is caused by wood smoke that results in 1.6 million premature deaths every year. [14], for example, estimated that in 2010, about 3.5 million premature deaths were caused by household air pollution (HAP) resulting primarily from cooking with solid fuels. They also estimated that there were 500,000 deaths from outdoor air pollution caused by household solid fuels use for cooking in developing Asia and Sub-Saharan Africa (SSA) in the same year. Although it is a worldwide issue the environmental impacts are more severe in developing countries, especially Africa (including Cameroon).

Apart from contributing to deforestation, it is estimated that the burning of wood in open fires and other inefficient stoves are responsible for close to 25% of emissions of black carbon.

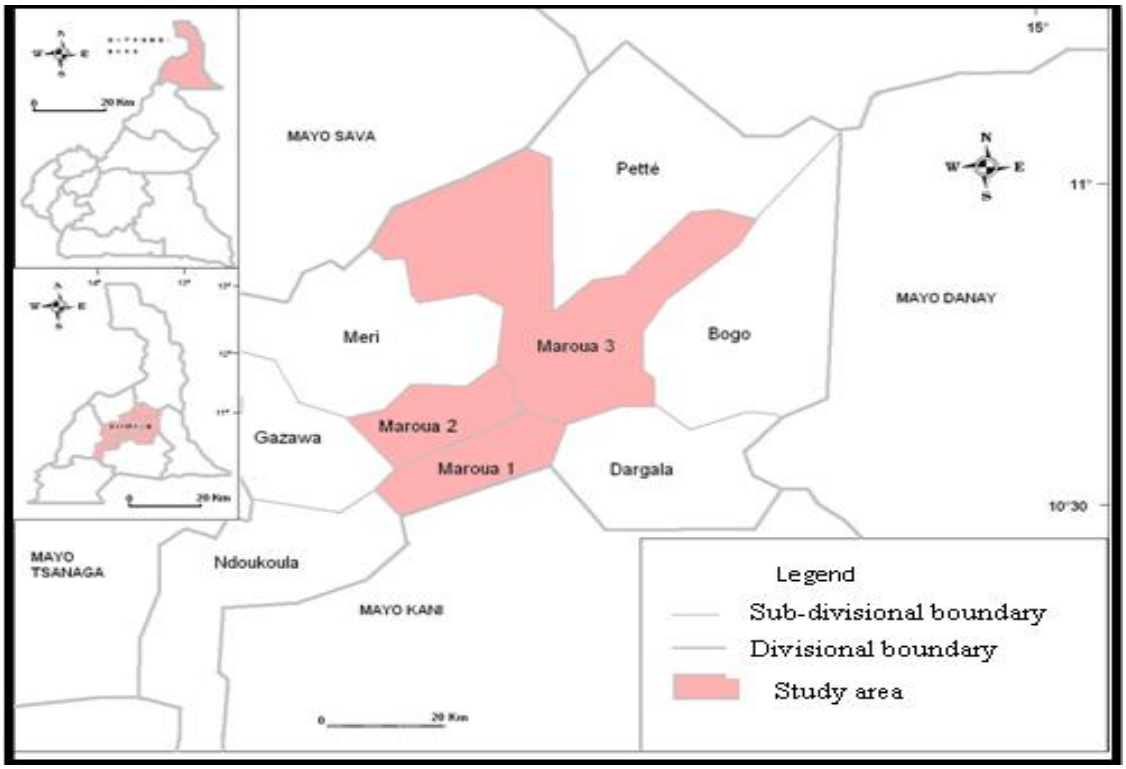

Fig. 1. Location of Maroua in the Diamaré Division, Far North Region of Cameroon
Inset: map of Cameroon location the Far North Region. Source: Maroua Urban Council (2014)

According to [15], black carbon could be a significant factor in the climate change currently being experienced. Like other neighboring Sahelian countries and towns, Maroua is highly vulnerable to the adverse effects of climate change [16]. This vulnerability is made more acute by the almost total loss of forest caused largely by demand for wood for cooking. The few remaining forest resources in Maroua in areas like Moutourwa, Mindif and Kay-Kay are under pressure and suffering from extensive deforestation and desertification. Buying and collecting wood puts a strain on households and on forest resources, threatening ecosystems and biodiversity, contributing to climate change and increasing communities' vulnerability to flooding (recurrent in Maroua) and poor agricultural soils [17].

By 2050, the World's population will be approximately 9 billion, with roughly 8 billion residing in less developed nations [18]. Meeting the energy needs of this increasing population puts tremendous pressure on already strained and damaged forest ecosystems and encourages continued harvesting of virgin forests. Together with the expansion of agricultural activities to support the expanding population, it is not surprising that globally, forests are disappearing at a rate faster than they are replenished [6,19]

Because the mutations in the household energy cook stoves in Maroua are not known, this study had as goal to critically examine the household cooking energy use and analyze the type of new cookers/cook stoves being introduced or promoted in the area as a suitable clean energy alternative to combat desertification and make recommendations.

1.2 Importance of the Study

Results of the study will help all the energy stakeholders in mapping out strategies for proper adoption of introduced alternatives.

2. RESEARCH METHODS

The study adopted a case study approach. In order to critically examine the current types of household energy and cook stoves, a semi-

structured household questionnaire was employed. The sample size was made up of six residential areas of 50 households each giving a total of 300 respondents (households) covering the three council areas that make up Maroua. The distribution of respondents by residential areas in Maroua is summarized in Table 1.

Table 1. Distribution of respondents by residential zones

Residential zones	Number of respondents	%
Domayo	50	16.7
Pitoare	50	16.7
Makabaye	50	16.7
Zokok	50	16.7
Harde	50	16.7
Dougoi	50	16.7
Total	300	100%

In order to ensure for a statistically sound representation of respondents, systematic sampling techniques was implemented. Questions were semi-structured, designed to gather pre-coded data as a means to facilitate data entry and analysis of the large sample size. Questions were asked orally by the field assistance either in French or Fulfude, the local language spoken in the area. The semi-structured household questionnaire had featuring four sections: identification, socio-demographic data, knowledge of energy efficient stoves and types of cooking energies.

To obtain information on the new alternative types of stoves being introduced, focused group discussion with 7 households was held. This took place in March 2013. The interview took place at the Government Bilingual Primary School premises amidst diverse participants from different households, occupation, sexes etc. In addition to this, formal interviews were also conducted with experts from “Institut de Recherche Agricole pour le Development” (IRAD), (forestry and wildlife specialist) and the Divisional Delegate Ministry of Environment, Nature’s Protection and Sustainable Development for the Diamaré. This was based on traditional biomass use and the introduction of modern fuel alternatives. It also aimed at understanding the government’s role in fighting deforestation, the functioning organigram and importance of the “Green Sahel Operation” that is currently going on in the region.

Ethnographic observations were undertaken throughout the research duration as a means to provide a holistic account of household energy and cooking stoves in Maroua, with insights into local culture and lifestyles. A participant as observer technique was used, whereby the research objective was known to those observed as opposed to covert observation. The majority of ethnographic accounts occurred during and shortly after the survey was administered. Households were followed as they engaged in cooking, with focus on observational guidelines such as type of stove used to prepare food, other stove types/ cooking fuels that are available to the household, what are the pot sizes, amongst others. Collected data was analyzed using descriptive statistics like percentages and tables.

3. RESULTS

From field investigations, the energy sources commonly being utilized are wood, charcoal and kerosene. This is because are relatively cheaper, accessible, and available and can be easily retailed (as from 100F CFA and 150F CFA in some places) in the quarters. Thus comparing with other energy sources, which cannot be retailed in little quantities such as liters, domestic gas seems to be expensive (3,250F CFA for a bottle of 6kgs and 6500 to 7000 F CFA for a bottle of 12 kg.). Consequently, most of the households frequently make use of two or more types of energy sources (Fig. 2). From Fig. 2, we realize that charcoal and wood are the most popular energy sources being used (48%) followed by wood and Kerosene (32%). There seem to be a particular preference for wood as it is used alongside all of the other energy sources. This suggests that the use of wood in the traditional 3 stone fire place is the most essential fuel source for the population (over 80%), in different forms such as wood and charcoal.

As a result of the scarcity of fuelwood, the traditional 3 stone fireplace has been modernised in order to minimize feulwood consumption. The typology of the modernized 3 stone fire place is presented in Fig. 3.

The improved three stone fireplaces are to an extent appropriate to the people’s cooking culture. This type of stove is disseminated in the area by the Heifer Project International, [HPI]. It is relatively cheaper and affordable as it requires little quantity of fuel wood (commonly known as firewood).

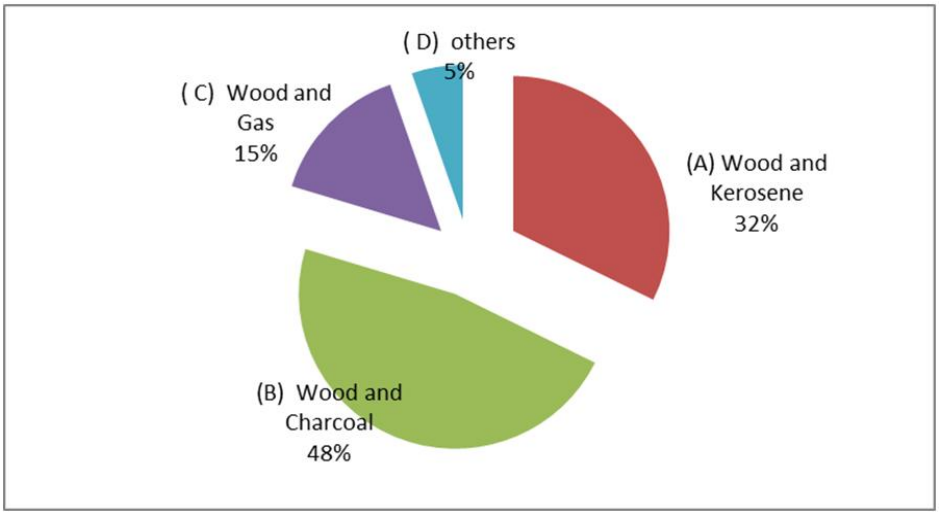

Fig. 2. Identification of frequently used types of cooking energy sources in the Northen Region Cameroon

Fig. 3. Two versions of improved three stone fire stove; triple burners

Currently, some of the major areas supplying fuel wood to the town have been witnessing reduction of their forest areas. These include Madjina, Songonye, Ngambarou, Moulvougaye and Kingeriwa. In these areas, the forest has been drastically reduced from 31.1% to 22.4% between 2004 and 2014 (10 years) (Table 2).

From Table 2, we realize that the forested area has been decreasing while that of sorghum cultivation has been increasing. Between 1975 and 1990, 590 km^2 of forested land has been lost due to felling of trees for fuel wood and agricultural practices. The area under sandy soils which are not good for agricultural exploitation has also been increasing.

Furthermore, the community of fuel wood consumers in the region is wide and varies from households to other petty traders who depend solely on energy from fuel wood. These include the local beer (bil-bil) brewers, roasted meat (soya) and fish sellers, blacksmiths, roadside restaurant ("puff-puff beans", fish fries as well as those who roast maize and potatoes), all depend on wood fuel (fire wood and charcoal) on a daily basis as their primary source of energy (Fig. 4). Thus, these different cooking styles emit different profiles of compounds influenced by factors such as cooking processes and ingredients [1,20] Their constant and ever increasing demand for wood fuel exacerbates deforestation for more fuel wood to meet up their demand.

Due to the high and ever increasing demand, the quantity of fuel wood consumed in the town has been increasing as the years go by (Fig. 5).

Table 2. Diminishing forested surface area (Km²) in the Far North Region (1975-1990)

Years	Forested area	Sandy soils	Sorghum cultivation area	Off-season sorghum cultivation zone	Non-classified
1975	2111	531	1479	2369	239
1984	2052	540	1112	2989	36
1990	1521	640	2033	2495	409

Source: Adapted from Madi and al (2002)

Fig. 4. Truck heavily loaded with firewood on daily distribution (retail and whole sale) to households and petty traders in Harde (Maroua)

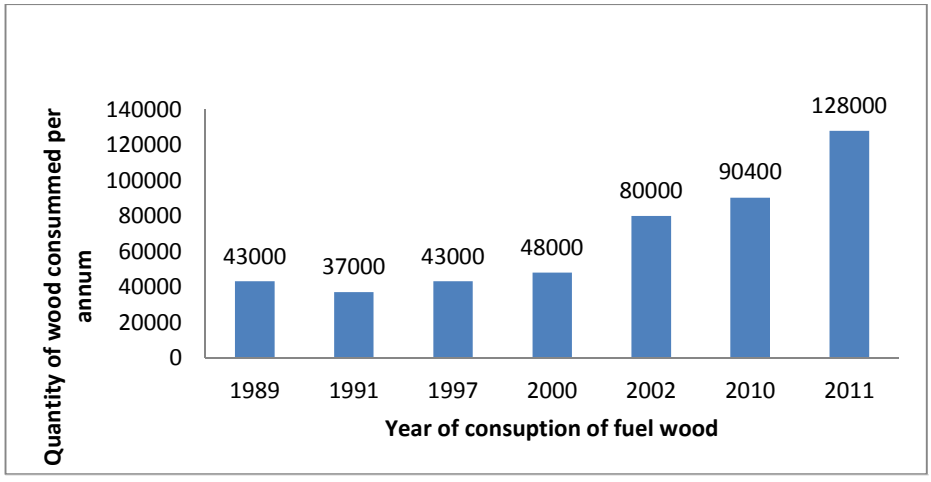

Fig. 5. Evolution of fuel wood consumption in Maroua Town. Adapted from Madi 2012

Fig. 5 illustrates that the quantity of fuel wood consumed in Maroua increased from 43,000 tons in 1989 to 128,000 tons in 2011, representing an outstanding 197% increase in the quantity consumed over a 22 years period mainly as a result of a galloping population growth. It was realized that fuel wood use in the town is problematic to both the inhabitants and the environment. The cutting down of trees to satisfy fuel needs engenders present and long term

health, economic, environmental problems. These include soil erosion, decreasing soil fertility and thus creating favorable conditions for desertification. As desertification continuous to encroach the Far Northern Region of Cameroon, many households continue to depend seriously on local traditional three stone fire place. This demands too much firewood due to considerable heat losses and as a result, the households spend enormous energy and time to get small quantities just for the day.

The predominance of fuel wood in household cooking is related to global climate change through two primary mechanisms: the extent that biomass for fuel wood is being harvested at an unsustainable rate (the rate of extraction exceeds the rate of replenishment) and so the capacity of the biosphere to remove carbon dioxide from the atmosphere is reduced; and because the combustion of fuel wood in household is incomplete, some of the carbon in the fuel wood is released in forms other than carbon dioxide, which may have a greater effect on climate. Because of deforestation, the amount of carbon that can be stored in the biosphere is continually decreasing, which results in a net increase of carbon dioxide in the atmosphere. In the most ideal biomass fuel cycle (one in which combustion is completed so that all the carbon is converted to carbon dioxide), if the biomass is harvested sustainably, emissions will be exactly offset by the uptake in carbon through the growth of forests. When the sustainability condition is not met, the rate at which carbon dioxide is emitted exceeds the ability of the forests to remove it from the atmosphere, resulting in increased atmospheric concentrations of carbon dioxide.

The above considerations suggest that household fuel wood energy in the area is in crisis. It is in this light that the Cameroonian governments via some of her national and regional institutions, have been putting in efforts to promote the use of Energy Efficient Stoves (EES) as an alternative source of clean energy. The Energy Efficient stoves represent stoves that use far less fuel biomass to cook the same amount of food and consequently produces far less smoke (and air pollution) than the traditional three stone fireplace. They are commonly referred to as Improved Cook Stoves (ICSs). Most of them are locally made from available local materials, are of low technology and reduce the amount of wood or charcoal consumption. The following types were identified; saw dust stoves, metallic improved stoves, Centrafricain stoves (foyer Centrafricain) and improved or modernized three stone fireplaces. Table 3 illustrates the photos, characteristic of the various energy efficient stoves diffused and adopted in the area of study.

The types of EESs or ICSs being promoted in the region possess different technical characteristics ranging from fabrication materials (clay and metals), sizes and energy sources (fuel wood, charcoal, cow dung, and sun). The choice of the type of stove and energy source is considered to be women's responsibilities but due to the patriarchy system, and economic hardship, women tend to depend on men (husbands) for the final decision on the type of stove to be used at home.

The cost, size, portability and presentation of the stove are some of the reasons that attract household heads / women to buy and use the EESs. A summary of the type, advantages, disadvantages, promoter and uses of some types of EESs adopted in the area are listed in Table 3. [The EESs were first introduced in Maroua by the following French organisations*: l'Association Française des Volontaires du Progrès (AFVP), l'Association Bois de Feu (ABF), and Commission des Communautés Européennes (CCE) et du Comité Français Contre la Faim (CFCF) [21]*. These organizations diffused the EESs evident with the semi-arid nature of the Far North Region so as to reduce the consumption of fuel wood and the pressure this exerts on the fast diminishing forests. Unfortunately, this diffusion did not last long as these organizations ran out of finances. Consequently, it was not until the early years of 2000 that the diffusion of the EESs continued by the *Programme National de Reboisement* (PNR) (National Program for Reaforestation) which had as objective the diffusion of EESs to zones that are endangered by the desertification phenomenon.

In 2008, the Ministry of Environment and Protection of Nature (MINEPDED) re launched the "Operation Sahel Vert" (Green Sahel Operation) ensuring the sustainable cutting of wood in addition to using sustainable and clean energy sources. Since then, the Regional Delegation of MINEPDED for the Far North Region (Maroua) has been distributing EESs to households in the region as a means of combating the wanton cutting down of trees (deforestation).

Table 3. Types and characteristics of energy efficient stoves

Metalic stoves

A cross section of energy efficient stoves sold in the Maroua market

“ Foyer Centrafricain”

Metallic stove

Saw-dust metallic stove

-Portable. Suitable for charcoal or firewood. Production provides source of income for artisans. Maximum 20-25% efficient
- Often of low durability due to use of flimsy cooking oil tins. Hot exterior can be dangerous
- Valorized by the ministry of environment, nature’s protection and sustainable development

Improved Mud Stoves

Improved three stone stove

Cone-shape improved mud stove

Simple multi-burner improved mud stove

-Easy to build. Require only locally available materials (anthill, donkey dung, mud, water, three stones).
-Can be sized to fit the family’s own pots. Can be maintained by the owner.
-Promote self-led innovation, 25% to 50% fuel efficient and saves time in cooking. Little and oriented smoke.
- However, disadvantages are as follows: Low durability requires regular repair (re-smearing) as it is non portable.
-Promoters include : Women’s groups, NGOs, HEIFER Project International, and Center for Appropriate Technology, Maroua

The distribution is done through the following circuits:

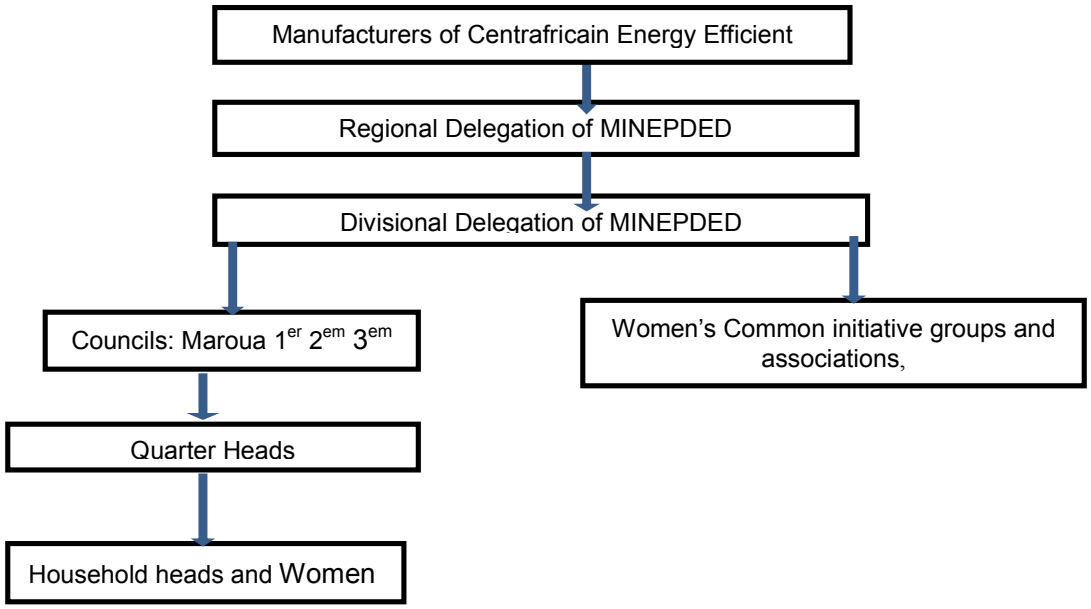

Fig. 6. Distribution circuits of "foyer Centrafricain"

The complete adoption of Foyer Centrafricain will go a long way to save households income [22] huge sums of households' revenue are spent on the purchase of fuel wood. An average household of seven members consume 1,865 kg of wood and 467 kg of charcoal per annum, equating it to the sum of 104,440FCFA and 70050 FCFA per annum. It is obvious that as the population of Maroua keeps on increasing, so will be the demand for fuel wood. Thus the adoption of EES will halve the cost and quantity of fuel wood within households. Fig. 7 shows the daily amount spent on fuel wood in the Far North Region of Cameroon.

Although household spend so much in firewood, some still find it difficult to completely part ways with the three stone fire place that is known for its low efficiency (heat loses during combustion) and multiple disadvantages.

The distribution of currently used stoves by the 300 households revealed the follwowing result (Fig. 8)

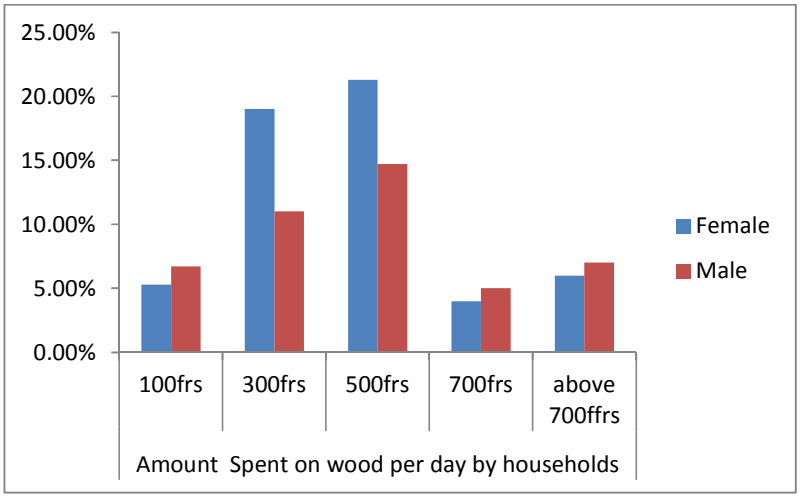

Fig. 7. Daily amount spent on firewood/charcoal

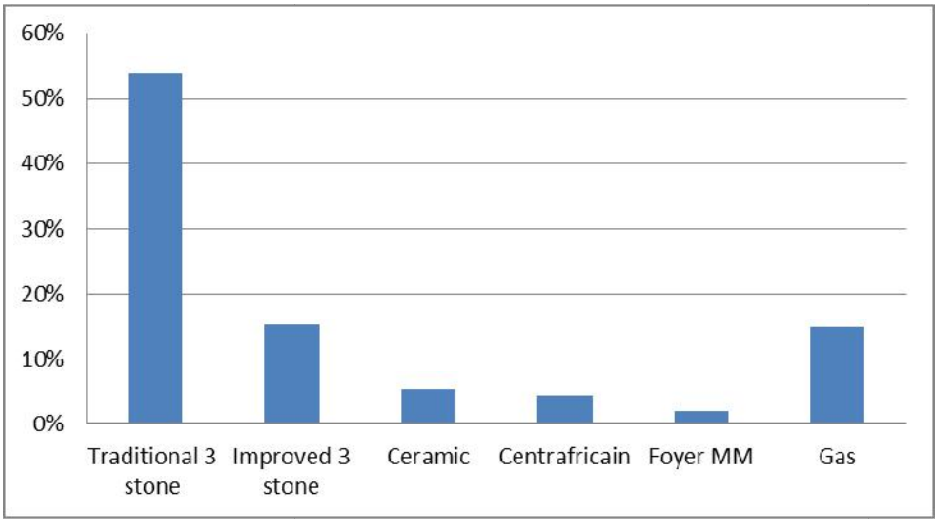

Fig. 8. Commonly used stoves in Maroua

Fig. 8 indicates that the three stone fireplace is the most widely used (54%) while the foyer MM is the least used as it stands at 2%. This can be attributed to the fact the traditional three stone fireplace can be located anywhere in the yard and the energy source which is firewood, can be bought in small quantities. Also tree branches from trees around the yard can serve as firewood. In addition, the three stone fireplace can support varrying pot sizes favourable to large household size [23]. Culturally speaking, it is believed that foods prepared on three stone fireplace tastes better (niebe, surghom-corn fufu and moringa soup) as firewood maintains heat for a long period of time. Lastly, it has been in use and passed down from generation to generation. Sunil and Govinda [1] confirms that behavioral and cultural factors such as household preferences, food tastes, cooking practices and cultural beliefs also influence cooking fuel choice. For example, people in rural Mexico continue to use fuelwood even when they could afford to use cleaner and modern fuels because cooking "tortillas" on LPG is more time consuming and negatively affects its taste.

The reasons for using Energy Efficient Stoves as reported by the respondents are many, diverse and include economical, saves time, protects the environment and less expensive to maintain (Fig. 9).

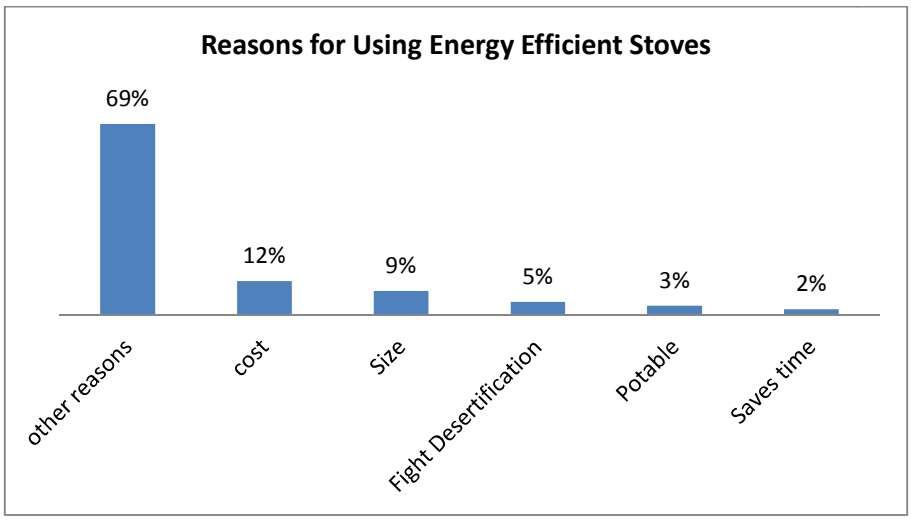

Fig. 9. Reasons for using energy efficient stoves
Source: Field Survey (2013)

4. DISCUSSION

This study confirms previous studies by [24] who notes that many households prefer fuel wood ([25] as their main source of cooking energy due to its easy access and divisibility as one can easily get wood for 20 ”Dollar Cents” in the quarters and markets. Meanwhile kerosene and gas are sold in liters, kilograms and might be costly for the user to disburse the amount needed at once. Schlag and Zuzarte [26] attribute the depletion of forest cover to environmental consequences such as erosion, desertification, decreased soil, moisture and quality and decreased biodiversity. Owsianowski and Barry [27] posit the advantageous nature energy efficient stoves to saving about 50% of the biomass and reduce considerably the phenomenon of indoor air pollution.

5. CONCLUSION AND RECOMMENDATIONS

This study critically examines household energy saving cookers in Maroua as well as makes suggestions for the use of other sources that are easier to harness and do not require long distance transportation and are environmental friendly. The availability of these sources would improve the quality of life of both the urban and rural population especially that of women and children who suffer the burden of ensuring a continuous supply of household fuel needs [28]. Harnessing other forms of clean energy and especially solar energy, biogas and EESs (which is the focus of this study) seem to be socially and economically viable for most households in Maroua. To resolve the energy crisis, it is recommended that:

- The government, NGOs, CIGs and private individuals should promote more sustainable cooking energy alternatives in an attempt to curb the adverse effects of the use of traditional sources like fuel wood on the inhabitants and the environment.
- Also, the Energy Efficient Stoves being promoted in the area should be designed such that they appeal to the socio-cultural needs of its intended beneficiaries or users. It is much easier to modify the stove design than it is to modify household cooking practices as to meet the requirements of the new technology. Introducing culturally acceptable stoves will therefore have a greater likelihood of being adopted and used by households in the long run. Blacksmiths should be encouraged to fabricate stoves that can carry large size pots and materials that can last for long because average family sizes demand large pots for cooking.
- It is also recommended that similar studies be carried out in other parts of the country. It will be worthwhile to carry out a cross cultural analysis comparing results from other regions of Cameroon in a bit to showcase Cameroon’s contribution in fighting global environmental problems like climate change and ensuring environmental sustainability (MDG 7).
- Government should revisit its method of sensitization and free distribution of subsidized energy efficient stoves in the area
- Finally, it is also vital that people should be properly trained to use the technology. Simply distributing EESs will not be enough to ensure successful adoption and use. Assisting the public during the introduction of improved energy services will foster better understanding and wider acceptance.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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