Consumption of fuelwood in households in Western Mbadjini region of Comoros

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ABSTRACT

Wood for fuel has been and is still the most dominant fuel for cooking in households in developing countries where more than half of the world population reside. High fuelwood consumption contributes to deforestation and forest degradation. Therefore, the aim of this study is to investigate the rate of fuelwood consumption of households in western Mbadjini region of Comoros. A survey design and quantitative/qualitative methods were adopted in this study for better collection of data. Specifically, a weight-survey method was used to measure the daily fuelwood consumption per household as well as per capita per day. The instrument for data collection was questionnaire. Data collected were analyzed using descriptive statistics. The result revealed an average rate of 15.1kg of fuelwood consumed daily per household (15.1kg/household/day) given an average per capita per day of 2.0kg and 732kg per capita per year (2.0kg/person/day, 732kg/capita/year). However, distinct rates of fuelwood consumption were obtained in different family sizes. Minimum, maximum and large Family size consumed 9.9kg, 17.4kg and 18.0kg per day respectively. Further, the results indicated that all the respondents were using fuelwood energy source for cooking and all of them depend on this energy source for survival (100%). Women were the main fuelwood collectors (53.3%) followed by children (23.7%). Further, the study revealed that majority of respondents (96%) preferred using fuelwood for cooking their meals. The free collection of fuelwood from the forest (60%), the rapid cooking of meal due to the use of fuelwood (25%) and the belief that the meal tastes very good when using fuelwood (15%) were the main reasons why respondents preferred using fuelwood energy. The most preferred tree species for fuelwood were *Nuxia pseudodentata*, *Gyrostipula comarensis*, *Psidium catleanum* and *Mangifera indica*.

INTRODUCTION

Forest ecosystem–based products have always played a key role in life-support systems such as energy requirements, food, fodder, shelter, clothing, and medicine (Murphy et al. 2008). This people–plant relationship contributes a great deal to human welfare (Tariq**,** 2016). In western Mbadjini region, people are deriving their daily fuelwood need from the Kartala forest. Households in western Mbadjini region depend overwhelmingly on biomass for cooking. In Comoros, fuelwood is highly used as energy for cooking in household in urban but more importantly in rural area where the majority of people reside. An overwhelming share of energy in Comoros (nearly 80%) is supplied for biomass (essentially wood fuel and agricultural residues) and households are the main consumer of that share (World Bank, 1988).

According to Pattanayak and his colleagues (2004) fuelwood is by far the most important source of biomass energy as it the primary energy source for more than 2 billion, primarily poor, people. Moreover, 99.9 percent of the total world rural population uses energy that is derived from biomass fuels (World Bank, 1988). Fuelwood is important and a vital need to households especially in developing countries where majority of people rely on wood for fuel (IEA, 2010). In industrialized countries, traditional biomass fuels, or particular wood fuels (fuel wood and charcoal), have long been replaced by more efficient and convenient sources of fuels. Nevertheless, even nowadays in many developing regions, especially sub-Saharan Africa, due to the poor affordability and accessibility of alternative sources, over 80 percent households are still heavily reliant on traditional fuels, primarily fuel wood, charcoal, dung and crop residues, to meet their energy needs (IEA, 2010), mostly for cooking and heating which affect the well management of a forest (Scholes and Biggs, 2004). As a critical factor, widespread poverty in many rural areas of developing countries, contributes to the continued dependency on biomass energy sources and persistence of traditional and inefficient ways to use them (Damte et al. 2012). With no requirement for complex, expensive equipment, wood has remained a dominant fuel and preferred form of domestic energy by people from undeveloped parts of the world (Arnold et al. 2003).

However, in developing countries, forests experience ruthless cutting of woody species, providing 50 percent of energy sources for cooking and heating homes (Shanley and Luz, 2003). A major reason for deforestation is greater dependence of the bulk of the world population on forests for their energy needs (Onyeneke, 2015). Regular unchecked harvesting of woody plants for construction, fuel, and agricultural tool formation has resulted in the decline of natural populations of trees (Tariq, 2016).

MATERIALS AND METHODS

Study area

Western Mbadjini region is one of the two regions of Mbadjini. It is also one of the 214 regions of Ngazidja Island, the biggest island among the four islands of Comoros (Ngazidja, Ndzouani, Maore and Mwali). Geographically, western Mbadjini region is located at 11°53'9.10"S and 43°26'7.37"E. The region is bordered by Hambou region to the West and Eastern Mbadjini region to the East. The North of this region is occupied by the largest forest of Comoros (Kartala forest).

Having a population of 28 117 in 2017 (INSEED, 2017), and 19 villages, the western Mbadjini region is one of the poorest region in Comoros. The main activity of this remote rural area is farming.

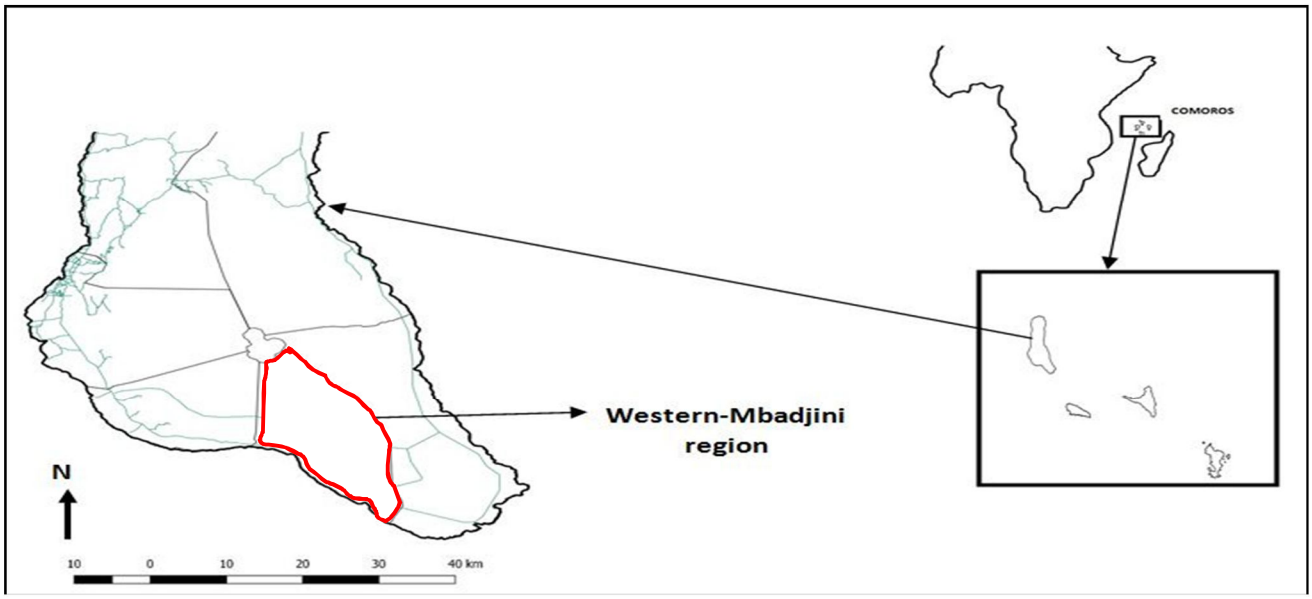

Figure 1: study site

Method adopted for fuelwood quantification

The Western Mbadjini region is composed of 19 villages and 5332 household units. Using the formula of Cochran, (1977) 135 households were sampled (from this total of 5 332 household units) to be surveyed in order to gather data on fuelwood consumption. Additionally, household were grouped into minimum family size (up to 4 members), maximum family size (6 to 10

members) and large family size (more than 10 members) in order to know how much quantity of fuelwood these different families were consuming. The method used to quantify the consumption of fuelwood was weight-survey method (Mijitaba and Jing, 2013). The method consisted of providing 3 weighted wood lots (fuelwood bundles) to household and household was requested and begged to burn wood only from the provided bundles in the next 2 days. After 2 days the researcher returned back to the household and measure the leftover of fuelwood. From this basis, the daily fuelwood consumption per household and per capita was revealed. Two days were selected to avoid factors that would affect the consumption such as lack of food, guest appearance, heavy meal and weather disturbance as followed by Asik, (2017).

Method of data collection and data sources

The study was conducted in western Mbadjini region in Comoros. A survey-design was selected as an appropriate research design of this study. Moreover, the research used both quantitative and qualitative method to collect data. Primary and secondary data were collected for this research work. Questionnaires provided primary data while secondary data was obtained from reports, documents, and published academic journals. Demographic characteristic data, including gender, occupation, family size, education status, fuelwood dependence and fuelwood preference were acquired by administering 135 questionnaires distributed to all the sampled households in 19 villages.

Data analysis methods

Descriptive statistics method was used to analyze data collected from the survey. The data were entered into Microsoft excel 2013 and IBM-SPSS software version 20 for better analysis. Arithmetic mean and percentage were used to interpret easily the result. In addition, graphs and tables were used to present the result.

RESULT PRESENTATION

Demographic characteristics of respondents

Age and sex of respondents

The study revealed that 71.9% of respondents were male while 28.1% of them were female. Age of the respondents were split into 4 sections or groups such as 18-25, 26-35, 36-45 and above 46 years. It was revealed that 48.9% of respondents were between the age of 36-45years. Although, 33.3% of respondents were between 26-35 years. In addition, 9.6% of respondents were between 18-25 years and 8.1% of respondents were above 46 years.

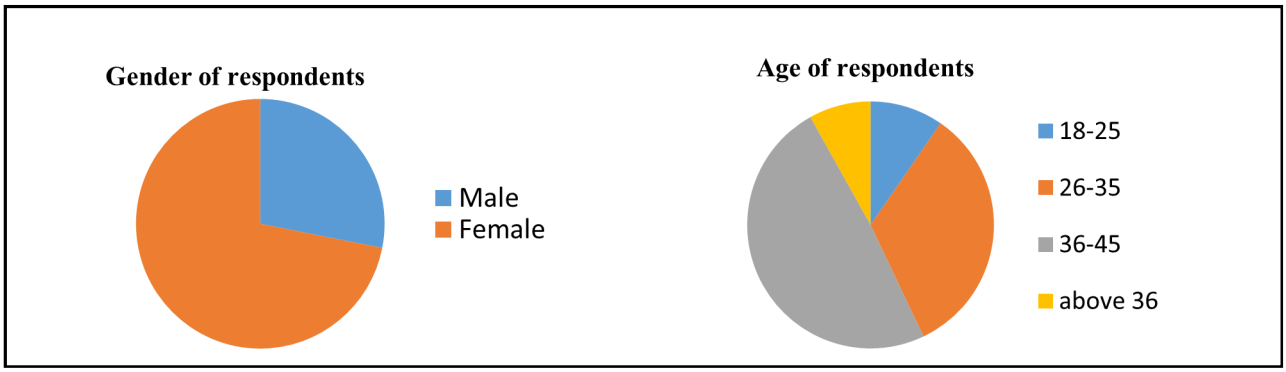

Figure 2: Sex and age of the respondents

Respondents' occupation

The study revealed that 45.2 % of respondents were farmers. However, 17% of respondents were fuelwood seller. House wife were 18.5%, traders represent 9.6% of respondents, and public servants were 9.6 %. From field observation, many people in the region especially women were involved in farming activities. It was also discovered that lots of people were fuelwood sellers as many points of fuelwood sale were observed in the region.

Respondents' family size

Family size was divided into three groups. It includes minimum family size (up to 4 members), maximum family size (6 to 10 members) and large family size (more than 10 members). It was revealed that 14.1% of respondents were found to have a minimum family size. However, 28.1% of respondents reported having a maximum family size and 57.8% of respondents had large family size. The study indicated an average family size to be 8.7 persons/household.

Table 1: family size of respondents

Family size	Frequency	Percentages
Minimum	19	14.1%
Maximum	38	28.1%
Large	78	57.8%

Education status of respondents

As a rural region, majority of people were illiterate. The result is clearly presented as follows: 55.6% of respondents were illiterate while 20.5 % represents respondents who only know how to write and read. Respondents who ended the education in primary, secondary, high school and university level were 10.3%, 6.9%, 3.7% and 2.8% respectively.

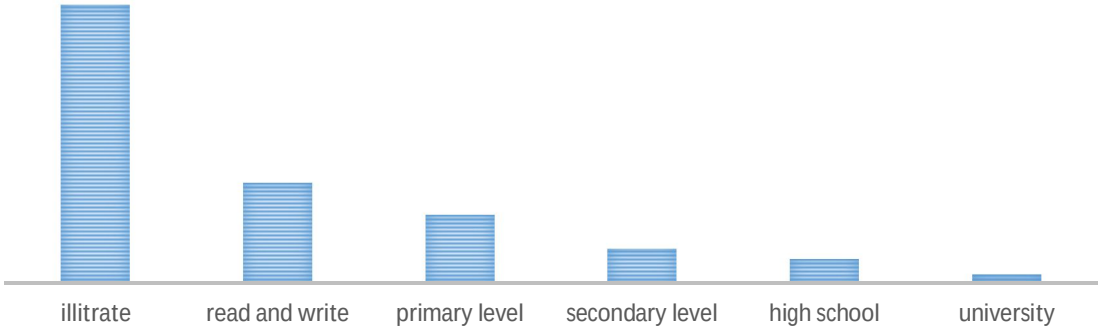

Figure 3: Education level of respondents

Fuelwood consumption

The quantity of fuelwood used in three different family size was revealed. The consumption of fuelwood in minimum family size was lower than the quantity of a maximum family size. Although, the consumption of maximum family size was slightly different from the consumption of large family size. The result shows that 9.9kg of fuelwood per day was consumed by minimum family size. However, in a maximum family size, 17.4kg of fuelwood per day was utilized. Large household size, on a daily basis consumed 18.0kg of fuelwood. Further, the result indicated that a household (no matter its size) consumed per average 15.1kg. (15.1kg/household/day). Additionally, 2.0kg was consumed per average per capita per day (2.0kg/capita/day).

Table 2: Fuelwood consumption by different household size

	Fuelwood consumption per different households size		
Family size	**Kg per day**	**Kg per capita per day**	**Kg per capita per year**
Minimum family size	9.9	2.5	900
Maximum family size	17.4	2.1	756
Large family size	18.0	1.5	540
Average	15.1	2.0	732

This above table shows that minimum family size consumes lower fuelwood than maximum and large family size. Maximum family size utilizes less fuelwood than large family which consumes much amount of fuelwood. In fact, the consumption of fuelwood of these 3 different family sizes differs from a village to another.

Table 3: fuelwood consumption by the 19 villages

	Distance to the forest	**Fuelwood consumption kg/capita/ day**			
Villages	CF=close to the forest FF=far from the forest	Minimum family size	Maximum family size	Large family size	**Average**
Ntsinimoichongo	CF	4.2	3.5	2.4	3.3
Makorani	CF	4	3.1	2.2	3.1
Itsoundzou	CF	2.3	2.1	1.8	2.0
Kadzile	CF	3.7	2.5	1.7	2.6
Mbounde yamboini	CF	1	1.9	0.9	1.2
Panda	CF	3.5	3.4	2.4	3.1
Dembeni	FF	1.5	2.5	1.2	1.7
Mindradou	FF	1.2	1.5	0.9	1.2
Madzissani	FF	2	1.7	1.1	1.6
Mlimani	FF	2	1.6	0.7	1.4
Dima	FF	1.7	1.1	1.2	1.3
Ouziwani	FF	3	1.5	0.6	1.7
Mdjakangnoi	FF	1.7	1.8	1	1.5
Domoni	FF	2.1	1.5	1.1	1.5
Ifoundihe chamboini	FF	1.9	0.9	1	1.2
Ifoundihe chadjou	FF	0.8	1.7	1.4	1.3
Dzoidjou	FF	2.2	1.4	1.3	1.6
Famaré	CF	3.7	3.3	2.4	3.1
Nkourani yassima	CF	4.2	3.5	2.4	3.3
Average	-	**2.5**	**2.1**	**1.5**	**2.0**

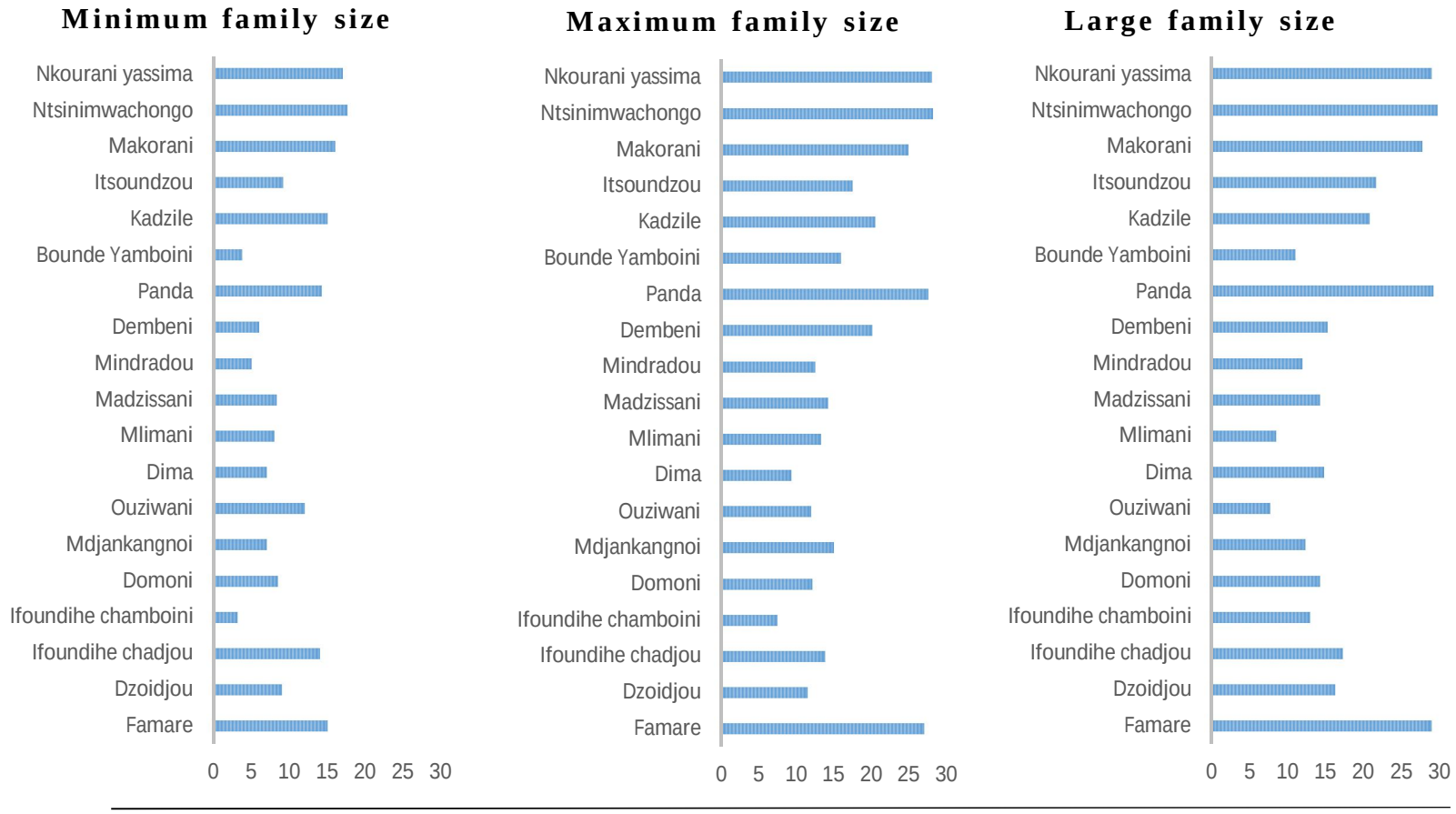

Figure 4: Fuelwood consumption in kg per day in different family size in different villages

This figure indicates that villages close to the forest including Famare, Nkourani yassima, Tsinimwachongo and Makorani consume much fuelwood than villages which are far from the forest such as Mindradou and Bounde yamboini. Nonetheless, fuelwood consumption differs from family size to another.In Table 3 the fuelwood consumption per capita increases when family size decreases. The average per capita fuelwood consumption of minimum family size is 2.5kg but a low value is calculated for maximum and large family size, 2.1 and 1.5 respectively.

Fuelwood collection and preferences

The study revealed that 70.8% of respondents were directly collecting fuelwood in the Kartala forest while 20% of respondents were buying fuelwood to meet their daily basis energy for cooking. Moreover, the main fuelwood collectors were found to be women (53.3%). Some respondents (23.7%) indicated that children were the fuelwood collectors in their households while 12.6% of respondents stated that men were the fuelwood collectors in their households.

Hundred percent of respondents were using fuelwood as energy for cooking(100%) and all of them reported that they depend on this energy for survival. However, 96% of respondents unveil that they don't only use fuelwood, but they also preferred using fuelwood energy over other alternative energies such as kerosene, electricity and gas to cook their meals. Some respondents (0.4%) indicated that they used fuelwood for cooking but they don't prefer it. These respondents further indicated that they cannot afford other sources of energy like gas or paraffin. The free collection of fuelwood (60%) from the Kartala forest, the rapid cooking of their meal with fuelwood (25%) and the belief that the meal taste very good when using fuelwood (15%) were the reasons why respondents prefer using fuelwood.

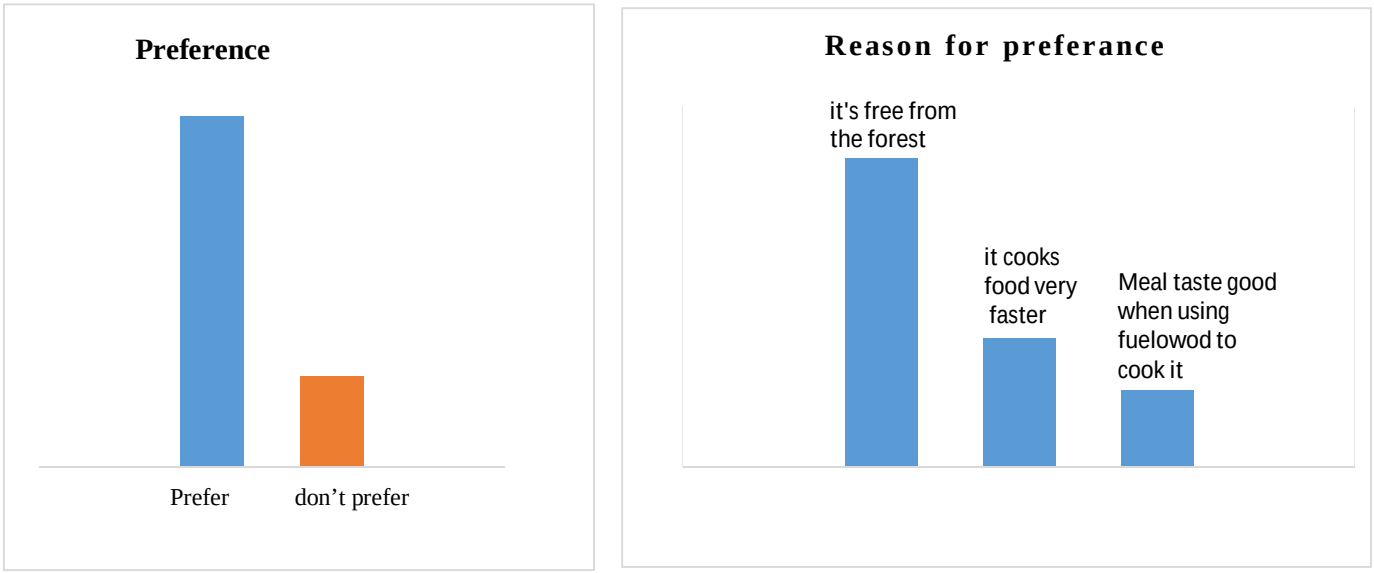

Figure 5: Fuelwood preference and reason for preference

Species used as fuelwood

Twelve tree species distributed into 9 families were identified as fuelwood species that respondents were using to cook their meals. These species includes *Nuxia pseudodentata, Gliricidia sepium, Psidium catleanum, Weinmannia comorensis, Gyrostipula comorensis, Pterocarpus indicus, Phyllanthus sp, Cynamomum zeylanicum, Psidium guayava, Vilex doniana, Albizia glaberima* and *Mangifera indica*. However, respondents were asked to determine their most preferred fuelwood species.

Table 4: Tree species used for fuelwood and their family names

No	Scientific names	Family name	Vernacular names
1	*Nuxia pseudodentata*	LOGANIACEAE	Mwanga
2	*Gliricidia sepium*	FABACEAE	Mgirsdia
3	*Psydium catleanum*	MYRTCEAE	Mtsoungoma
4	*Weinmannia comarensis*	CUNONIACEAE	Mdrikoundi
5	*Gyrostipula comorensis*	RUBIACEAE	Mtrakouni
6	*Pterocarpus indicus*	FABACEAE	Mbarouti
7	*Phyllanthus sp*	EUPHORBIACEAE	Mrounda tsoulé
8	*Cynamomum zeylanicum*	CANNELACEAE	Mdarassini
9	*Psydium guayava*	MYRTCEAE	Mpera
10	*Mangifera indica*	ANACARDIACEAE	Myembe
11	*Vitex doniana*	VERBENACEAE	Mfili
12	*Albizia glaberima*	FABACEAE	Mdjendjeye

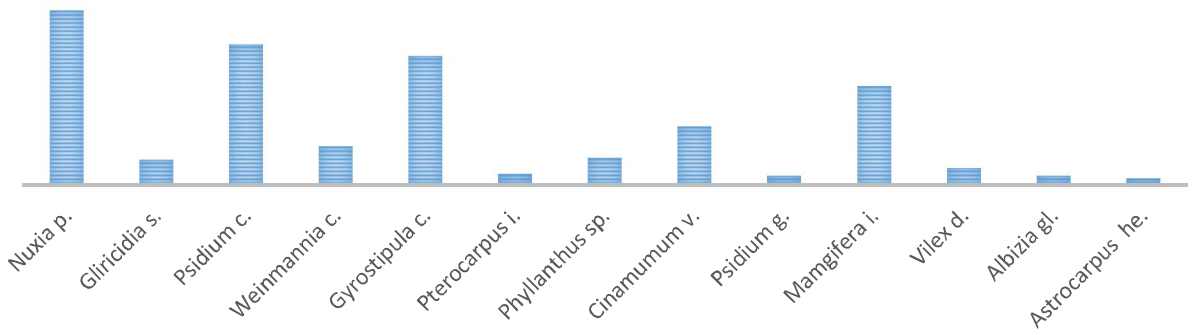

Figure 6: Fuelwood species preferences

RESULT DISCUSSION

Demographic characteristic

The study revealed that majority of respondents were female (71.9%) and range within the age of 36 – 45 years (48.9%). Female respondents were expected to participate more in this study as they are more likely to know much information about fuelwood consumption. This is because, women spend much time in the kitchen cooking meals using fuelwood especially in developing country where women are culturally and traditionally believed to remain home for cooking and serving the family. Therefore, the majority of respondents were female and mature enough to

provide reliable and trust-worthy information on household activities which were relevant to this study. This result agrees with the result of Berhanu, (2017) who found in his study that majority of respondents were female (63.7%) and their age fell within the age group 25-35 years (50.4%) implying that respondents were responsible and capable of providing reliable information.

Educational level of respondents were also revealed. The result indicated that 54.1% of respondents were illiterate and 18.5% knew how to read and write only. However, some respondents ended their educational career at primary level (10.3%), secondary level (6.7%), high school (3.4%) and university level (6.7%). Thus the result of this study indicates that the majority of respondents were illiterate and uneducated. Uneducated people are more likely to be poor and poor people have high effects on forests especially in developing countries where wood-based fuels remain the dominant source of energy for over 2billion poor people (Trossero, 2002), and these people put much pressure on forest resources which they depend on. Onyeneke, (2015) found that less educated people consume much fuelwood.

About 57.8% of respondents had large family size while 25.1% and 14.1% of respondents claimed that their family size were maximum and minimum respectively. The mean family size was calculated to be 8.7 persons per household. However, this value is higher than the mean value of family size reported by Mislimshoeva et al. (2014) in Western Pamirs, in Tajikistan (6 persons/hh). Berhanu, (2017) reported a mean value of family size to be 7.1persons/hh which is also high than the value calculated in this study.

In Western-Mbadjini region, farming activity is practiced by the majority of people as a mean of survival. This study revealed the respondents' occupation and 45.2 % of them were farmers while 17% were fuelwood seller. Additionally, 18.5%, 9.6% and 9.6% of respondents were housewife, trader, and public servant respectively. This result divulged that majority of respondents were farmers. Onyeneke, (2015) found in his study that farming activity has a relationship with fuelwood consumption implying that farmers influence/increase the consumption of fuelwood. Therefore, in an area where majority of people are farmers, the consumption of fuelwood is more likely to be higher which in turn affect the forest.

Fuelwood consumption

Developing countries' households have mostly large family size which is one of the factors that contributes to high consumption of fuelwood which in turn add on deforestation and forest degradation. In this current study conducted in Western Mbadjini region of Comoros, majority of respondents' households had large family size (57.8%) and per average 8.7 persons were living in a household (8.7persons/hh). In point of fact, the result revealed that minimum family size consumes low fuelwood than maximum and large families as confirmed by Bhatt and Sachan, (2004) who reported that large households consume more fuelwood than those of medium and small families. The study indicates that per average minimum family size consumed 9.9kg of fuelwood per day while maximum and large family size consumed 17.4kg and 18.0kg fuelwood per day respectively. Even though the result of Asik, (2017) differs from the result of this study, but his study confirms that minimum family size consumes low fuelwood than maximum and large family size as his result indicated that small family size consumed 13kg per day and medium and large family size consumed 21kg and 34kg per day respectively.

However, according to Munesh, (2015) fuelwood consumption with family size reduces with increasing family size from small, medium and large family size, implying that small or

minimum family size consume much fuelwood than medium and large family size. But this was based only on the fuelwood consumption per capita of family size. Therefore, this study found that consumption of fuelwood by household increases with increasing of family size as indicated in table 2.

In fact, the consumption of fuelwood per capita decreases with increasing family size from minimum, maximum and large family size as reported by Munesh, (2015). Obviously, the consumption of fuelwood per capita in small family size should be higher than those of medium and large. This is because to obtain the consumption per capita, the total amount of fuelwood consumption is divided by the total number of family members. Therefore, as small family size has few members the amount of fuelwood per capita tends to be high than those of medium and large family sizes as they have many family members.

This study also agrees on the fact that fuelwood consumption per capita decreases with increase of family size. The study reveals 900kg/capita/year in minimum family size and yet in maximum and large family size 756kg/capita/year and 540kg/capita/year were calculated respectively. Although, these values are higher than those of Munesh, (2015) who found in the region of Garhwal in India that 669.58kg/capita/year in small family size, 543.35kg/capita/year in medium family size and 441.88kg/capita/year in large family size.

The average per capita per year was revealed to be 732kg which is also higher than those of other studies. Mehat et al. (1987) reported fuelwood consumption of 448.95kg/capita/year for Nepal Himalaya. Dhanai et al. (2014) reported a value of 646.05 to 1091.35kg/capita/year. Jaiswal et al. (2013) reported in their study that the fuelwood consumption was 657kg/capita/year which is also a low value than the value obtained in this study.

CONCLUSION AND RECOMMENDATION

Fuelwood is the main fuel energy mostly used for cooking in households in developing countries. This study found that the rate fuelwood consumption was higher which can contribute to deforestation and forest degradation in Western Mbadjini region in Comoros. Further, the study indicated that majority of respondents had large family size from ten up to eighteen members, which influences the consumption of fuelwood. Therefore, there is immediate need to lessen the rate of fuelwood consumption in order to reduce the pressure on forest resources. In addition, alternative energy sources such as kerosene and cooking gas should be harnessed and provided in the region to encourage a shift from environmentally unfriendly fuelwood to more sustainable energy sources. Moreover, it was indicated in this study that majority of respondents were illiterate, uneducated and farmers, therefore Government and non-government organizations should embark on public enlightenment campaigns to inform and sensitize the people within the region on the consequences of fuelwood consumption such as forest loss, climate change, biodiversity loss and forest degradation. The study revealed also that *Nuxia pseudodentata*, *Gyrostipula comarensis*, *Psidium catleanum* and *Mangifera indica* are the most tree species preferred for fuelwood. Therefore, recommendation is made that these species should be planted more in the Kartala forest.

More research should be done regarding the status and availability of these fuelwood species in the Kartala forest.

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