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**Understand the Energy Demand Behaviours for a Sustainable Management
of the Natural Resources in Cameroon.**

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Abstract

In order to fall under a prospect for sustainable management of the natural resources in Cameroon, this communication tries, using a 1996 survey carried out from 400 households in the towns of Yaounde, Mbalmayo and Ebolowa, to understand the demand behaviours of the urban households, with respect to the various sources of energy. The work aims to highlight the place of the firewood like source of energy. The results obtained confirm the important place of the firewood in its various forms like source of energy in urban areas and thus indicating a threat on the future of the natural resources, in particular forest, in Cameroon. The income-elasticity analysis showed that, contrary to “modern” fuels that are the oil and the gas which are normal goods, the fuels containing wood (wood, coal, sawdust) are inferior goods which decrease when the income increases. An improvement of incomes in the urban households is a solution to sustainable management or conservation of the natural resources in Cameroon.

Key words: Energy; household surveys; demand; income-elasticity; natural resources.

1. Introduction

“Today, the control of energy demand is a first condition of the sustainable development. All the long-run scenarios, in world level, show the need for this control without which the puncture on the rare resources and the attacks on environment would quickly become so intense that the development of humanity, and even her survival would be in question”. This quotation extracted from the Mr Benjamin DESSUS’s communication, French Commission of the sustainable development underlines the interest of the control of energy demand to ensure to all a sustainable development.

In the developing countries, in particular African, the question of the control of the energy demand for a sustainable development is often answer in term of exhaustion of the energy resources following a fast increase of population. Indeed, one of the remarkable phenomena of these ten last years in Africa is the strong growth rate of the population, and the accelerated evolution of the rate of urbanization (Sai Fred, 1990; McNamara, 1991).

In Cameroon the population passed from 10.5 million inhabitants in 1987 to 13 million in 1995. Demographic projections provide that it will be some 25.5 million people in 2020. The danger which this fast rate of demographic growth poses in the long run, is that of the threat on the environment, through the firewood consumption.

According to Cleaver and Schreiber (1994), the strong dependence with regard to woody fuels combined with a fast demographic growth contributed to intensify the pressure exerted on the natural resources. Statistics from the Department of the Environment (1996) show that, 80% of the Cameroonian population draw its energy from the wood whose consumption should be at 12 million m³, that is to say four times the national consumption of industry.

If it is true that the level of consumption and commercial flows are still badly known, it is however obvious that apart from the great agglomerations such Douala and Yaounde where part of wood power consumption comes from the rejects of industry including the sawdusts (Department of the Environment, 1996), the near total of wood energy comes from the food fields and the forest formations (Demenou, 1997). However, the artificial regeneration rates of the forests in Cameroon are still lower than the rates of extraction (Department of the Environment, 1996).

This threatening situation on sustainable management of the forests puts forward the urgency that there is to encourage the populations, especially those of the urban zones, to adopt alternative sources of energy. With this intention, it is important today to well understand the behaviour of the populations with respect to the various sources of energies.

The objective of this communication is to analyze the demand of fuels used by the urban households in Cameroon. For that, one will test, thanks to an investigation carried out by Nkamleu and al. (2002), to understand the energy demand behaviours of the Cameroonian urban households by analyzing the following points:

- The monthly average expenditure of fuels (paraffin oil, firewood, charcoal, sawdust, gas domestic) in the households;
- The place of wood and its derivatives in the energy expenditure of the households;
- The distribution of the households according to the importance of fuels;
- The income elasticity of the energy consumption in Cameroonian urban areas.

The goal is to set up the useful elements to be included in strategies that reduce the levels of woody fuel uses by protecting the environment and forests.

2. Characteristics of the survey

The study was carried up in three great agglomerations of the provinces of the Center and South. The town of Yaoundé and Mbalmayo in the Center and the town of Ebolowa in the South were the places of the investigations. As all African urban zones, these three cities are characterized by a fast growth of the population. Between 1976 and 1997, the population in the cities has triplet (Ministry for the economy and finances, 1997). It increased very quickly in Yaoundé, administrative capital of Cameroon, and Ebolowa which become the chief town of the South province. As for Mbalmayo, the increase of its population can find its explanation in its proximity with Yaoundé. The survey was carried out during November 1996 in the households of those three cities, using a questionnaire with single passage. A random sample of 400 households was interviewed, namely 200 households in Yaoundé, 100 households in Mbalmayo and 100 households in Ebolowa. The questionnaire used is subdivided in four modules:

- Type of housing;
- Characteristic of the head of household;
- Cost of various fuels used in the households;
- Firewood supply;

3. Data analysis and results

The collected data were analyzed by means of elements of the descriptive statistics such as the frequencies, the averages and the percentages. In addition, the estimate of the Engel curves (Nkamleu and al. 2002) made it possible to calculate the coefficients of income-elasticity for each source of energy (firewood, coal, gas, etc).

3.1 Description of the variables used

The energy demand is often a function of the gender, of the household size and the level of income of households.

Gender. The sex of the head of household is an important parameter which is a determinant in the energy demand behaviour of a household. In general, the men are mainly the heads of household. It is the case in our sample where more than 61% of the households have a man as chief. It is in the town of Yaoundé that one meets the greatest number of households having woman as head of household (47%), come after Ebolowa (42%) and finally Mbalmayo (41%). The results of the investigation do not make it possible to say if wood and its derivatives are more or less required according to whether the head of household is a man or a woman.

Size of households. The number of people composing the surveyed urban households oscillates around 7 people by household. This average does not substantially vary from one city to another. In their composition, however, Ebolowa seems to have more children (6 on average) than Yaoundé and Mbalmayo. 69% of the households classify wood like the first source of energy. One can thus think that the energy demand, in particular wood, is higher in the households of big sizes than in the small ones.

Level of income. It is in general difficult to determine the levels of income, because of the reserves which the individuals express to declare their budget. During the investigation, some

individuals revealed the monthly income of their household, which makes it possible to make comparisons between the levels of income compared to the sex and the zone of residence. The average monthly incomes in the households are rather high as shown in table 1. The average monthly incomes appear to be relatively higher in Ebolowa. This level of income is, on the other hand, low in Yaoundé and Mbalmayo. This situation can find its explanation in the fact that in Yaoundé the greatest number of heads of household carry on liberal activities or then are without employment. Generally, the monthly incomes of the men are close to the double of those of the women. This space inequality of the incomes does not allow a good reading of the impact of the income on the energy demand. This is why we considered an analysis in terms of elasticity (see paragraph 3.4 below).

Table 1: Monthly average income of the households in FCFA

	Yaoundé	Mbalmayo	Ebolowa	Total
Man	65 583	61 625	83 333	66 521
Woman	35 470	38 600	41 500	36 708

Source : 1996 survey (Nkamleu and al., 2002)

Table 2: Distribution of the households (%) according to the importance of fuels (classified by ascending order of importance: 1st, 2nd, 3rd, 4th)

YAOUNDE				
	1st	2nd	3rd	4th
Oil paraffin	29	32	8	28
Firewood	31	38	36	0
Coal	0	0	13	0
Sawdust	5	6	25	29
Gas	35	24	18	43
MBALMAYO				
	1st	2nd	3rd	4th
Oil paraffin	9	14	35	20
Firewood	50	54	12	0
Coal	0	0	0	60
Sawdust	28	19	18	20
Gas	13	14	35	0
EBOLOWA				
	1st	2nd	3rd	4th
Oil paraffin	9	17	50	50
Firewood	69	32	12	0
Coal	0	2	13	0
Sawdust	3	9	12	50
Gas	19	40	13	0
OVERALL				
	1st	2nd	3rd	4th
Oil paraffin	19	24	20	29
Firewood	45	40,6	27	21
Coal	0	0,4	9	0
Sawdust	11	10	22	29
Gas	24	25	22	21

Source : 1996 survey (Nkamleu and al., 2002)

3.2 Place of wood and its derivatives in the energy demand of the households

The households generally use five types of fuels. The importance attached to each type depends on the households. Table 2 indicates the percentage of the households according to the place and the order of importance of fuels used.

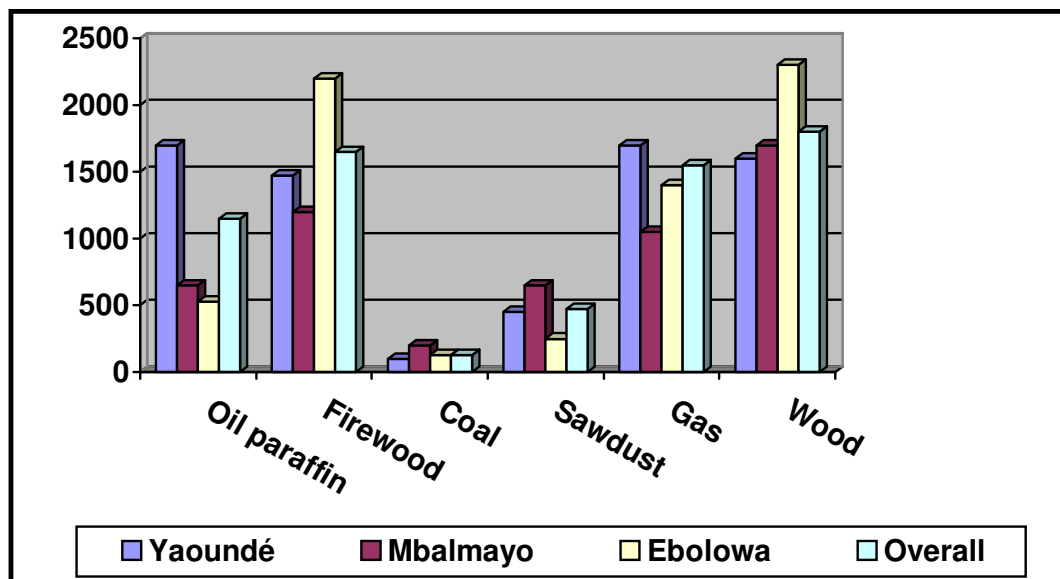
In the town of Yaounde and according to the importance which each household grants to fuels, the domestic gas comes in first position. In 35% of the households it is the source of the most used energy. Then the firewood and the paraffin oil with 31 and 29% of the households which classify them in first position respectively. The sawdust is well used too, and it comes in first position in 5% of the households. In the town of Mbalmayo, and by order of importance of fuels, the firewood comes to the first rank in 50% of the households. It is followed by the sawdust and domestic gas in 28 and 13% of the households respectively. In the town of Ebolowa, the firewood is still much more important. It is the more used fuel in 69% of the households. It is followed by domestic gas in 19% of the households.

Generally the firewood is the most important fuel for the households of the forest urban zones of the South Cameroon. It is classified as most important by 45% of the households. It is followed by domestic gas and paraffin oil in 24 and 19% of the households. The sawdust is classified in first place by 11% of the households. The coal is rather used in a marginal way.

3.3 Energy expenditure of the households

Figure 1 shows the level of the monthly average expenditure for various fuels in the households in towns of Yaoundé, Mbalmayo and Ebolowa. In the town of Yaoundé the households spend monthly 1,820 FCFA for domestic gas, 1,655 FCFA for the purchase of the oil paraffin and finally 1,393 FCFA for the firewood. The expenditure allocated to the sawdust represents close to the fifth of the expenditure for the firewood. As for the coal, the expenditure which is allocated to him is marginal. In the town of Mbalmayo, the households spend on average 1,082 FCFA to buy the wood. They allocate a little more half of the wood expenditure for the paraffin oil (630 FCFA) and the sawdust (564 FCFA). The gas domesticates costs them on average 892 FCFA, a little more than five times the monthly expenditure of the coal. In the town of Ebolowa, the monthly expenditure of the households of wooden rises to 2,251 FCFA, that is to say more of the double than in Mbalmayo. The gas domesticates costs them on average 1,395 FCFA. The oil expenditure rises to 477 FCFA, those of the sawdust and the firewood are 146 and 67 FCFA respectively.

Figure 1: Monthly average expenditure in FCFA of fuels in the households by zone in 1996.



In all three cities, the monthly expenditure between the wood, domestic gas and the paraffin oil is almost distributed in a homogeneous way (1,540; 1,505 and 1,126 FCFA respectively). The monthly expenditure for the sawdust and the coal represents twentieth and the fifth of those allocated to wood.

Figure 2: Place of wood and its derivatives (sawdust and charcoal) in the energy expenditure

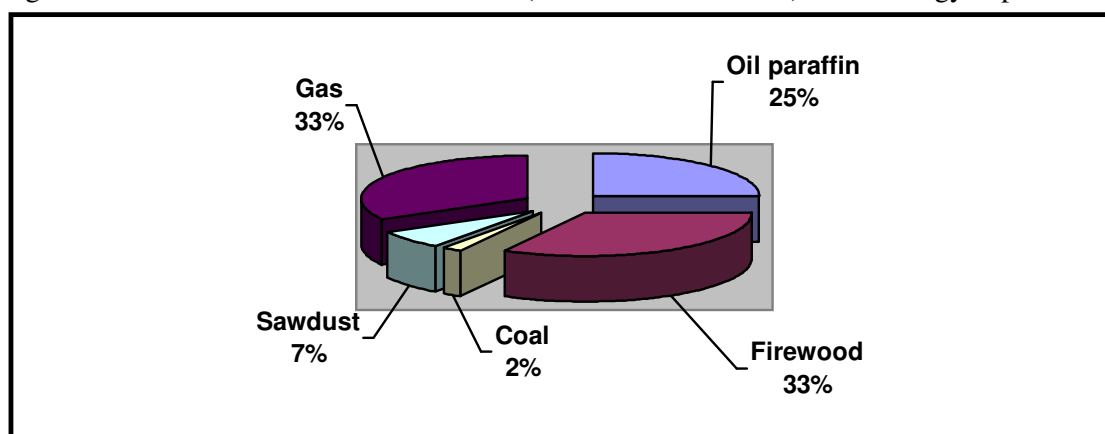


Figure 2 shows the place of the firewood and its derivatives (sawdust, coal) in the total energy expenditure of the households. Thus, the heating wood and the domestic gas occupy the greatest part of the expenditure, with 33% each one. The paraffin oil accounts for 25% of the energy expenditure, while the sawdust and coal account for 7 and 2% of the expenditure respectively.

3.4 Income-elasticity of the energy consumption in Cameroonian urban zones

For the calculation of elasticities, one distinguished two zones: the town of Yaounde which is high urbanized on the one hand, and towns of Mbalmayo and Ebolowa which are less urbanized on the other hand. From the model of Working (Deaton and al., 1980), we

estimated Engel curves which enabled us to calculate the coefficients of elasticity-income for each source of energy (firewood, coal, gas, etc). The model which was estimated for each source of energy presents as follows:

$$W_{ij} = \alpha_{ij} + \beta_{1ij} \text{LOGREV} + \beta_{2ij} \text{TMENA} + \beta_{3ij} \text{SEXE}$$

where W_{ij} = Share of the family budget of the household “i”, devoted to the source of energy “j” [(expenditure j)/(income)] ;

LOGREV = Logarithm of the head of household income (it is supposed here that the income of households is spent for the purchase of the various goods and services);

TMENA = Size of the household. Together of people with or without family link living under the same roof;

SEX = Sex of the head of household (1 = man; 2 = woman). The marginal share of

expenditure for energy j, , $\theta_j = \frac{\partial(\text{DEP}_j)}{\partial(\text{REVENU})} = W_j + \beta_{1j}$ and the elasticity of expenditure is

$$\text{given by: } \eta_j = \frac{\partial(\text{DEP}_j) / \partial(\text{REVENU})}{\text{DEP}_j / \text{REVENU}} = \frac{\theta_j}{W_j} = 1 + \frac{\beta_{1j}}{W_j}$$

where:

DEPj = total expenditure of consumption for energy j;

Wj = DEPj/REVENU = proportion of the expenditure for the source of energy j

alpha_i and beta_{ij} are the parameters to be estimated.

The estimate of this equation made it possible to calculate various elasticities. Table 4 shows the computed values of the income-elasticity of demand for all the energy sources in this study. Globally, and in all the zones, one can see clearly that oil and the gas have positive elasticities and lower than 1. An increase in the income involves an increase but that is less proportional than expenditure allocated to these fuels. This result indicates that these two fuels are normal goods.

Table 4: Income-Elasticity of the energy consumption

	Yaoundé	Mbalmayo/Ebolowa	Globale
Gas	0,92	0,74	0,67
Oil paraffin	0,01	0,01	0,02
Wood	- 1,38	0,56	- 0,43
Coal		- 2,13	- 1,20
Sawdust	0,53	- 3,58	- 1,25
Woody total products	- 1,02	- 0,23	- 0,60

Source : Calculations of Nkamleu et al. (2002).

The fuels containing wood correspond to another reality. All in all, the income-elasticity of the fuels demand containing wood are negatives. When the level of income increases, the consumption expenditure of woody fuels decreases in nominal term. Wood and its derivatives thus constitute inferior goods, with however some characteristics according to zones'.

In the zone with strong density of population (Yaoundé), the sawdust appears being a normal good, which can be explained by the fact that in Yaoundé, the use of the sawdust is mainly met in the households having the suitable adapted equipments. The poor households, not being able to have these adapted equipments, will use less the sawdust. On the other hand, in

the zone of Mbalmayo/Ebolowa, the sawdust is obtained free because of the proximity of the sawmills, so that the sawdust is the fuel of the poor, and when the income of the individuals increases, they dissociate use of this product.

Another outstanding fact is the positive sign of the income-elasticity of wood in the forest belt of Mbalmayo/Ebolowa. That can be explained by the fact that in the forest belts, the culinary practices are directed towards the use of wood because of its availability. This is why the firewood is the most important energy expenditure in the zone of Mbalmayo/Ebolowa. In the zones strongly urbanized like Yaoundé, on the other hand, wood is less available, and the use of wood is in the majority of the case incompatible with the environment and the structures of dwelling. At all events, it remains that the woody fuels (wood, coal, sawdust) have negative elasticities when one considers the total data of the investigation.

4. Conclusion

Starting from an investigation carried out in 1996 near 400 households of the towns of Yaounde, Mbalmayo and Ebolowa, our communication tried to put forward some variables making it possible to understand the energy demand behaviours in the urban households for considering well a durable management of the natural environments in Cameroon.

The results obtained indicate an important place of the firewood in all its forms like source of energy in urban zone, in spite of the prevalence of the “modern” fuels which are mainly oil and the gas. Moreover, the space analysis shows that when one moves from cities strongly urbanized towards less urbanized cities, one notes an increase in the importance of wood and its derivatives like source of energy, also the expenditure which is allocated to them. Oil and the gas have, on the other hand, a contrary evolution.

This important place that the firewood in the energy demand occupies lets predict a threat on the durable management of the natural environments, in particular forests, in Cameroon. To dissipate this threat, our research indicates a principal track to us : elasticities made it possible to note that, contrary to “modern” fuels that are the oil and the gas which are normal goods, the fuels containing wood (wood, coals, sawdust) are inferior goods which decrease when the income increases. In clear, an improvement of the income of households is a solution because the households with low income consume more firewood than the households with high income. There is thus a true effort to make the households with low income for a greater promotion of the sources of alternative energies.

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