

**Economic Analysis of Determinants of Potable Water Consumption in Yaounde (Cameroon) and Strategies for Sustainable Management**

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**Abstract**

Sustainable management of drinking water requires knowledge of the factors which affect the household expenditure on the resource.

To attain this objective, a questionnaire was administered to some households in Yaounde and linear regression techniques were used to determine the factors that can explain water expenditure.

The main determinants were found to be; the type of housing, the size of the household and the income of the head of household.

Therefore, to avoid over-exploitation of water resources, high water bills, illnesses related to water of poor quality, unavailability of water, it is imperative to sensitise the population on the need for the sustainable management of natural resources in general, and water resources in particular, through the mastery of the factors affecting the cost of water per household.

**Keywords:** drinking water, externalities, natural resource, environment, economic good, public good.

**Introduction**

Although water is available in sufficient quantity in Cameroon as a whole, the most important problem is that of its distribution and especially that of the quality .

However, because of retrograde mentalities on the one hand, "water is a gift of God"; and on the other hand an improbable reduction of the needs in the years to come (Cameroonian population increases with an annual average growth rate estimated at 3 %), it is possible that in the nearest future, the country faces recurring drinking water problems in quantity as well as in quality.

In this respect, this study aims first, to show that water is an integral part of economic goods and must be treated as such (I). A rational management of the resource is essential then. This is possible, at the individual level, by the control of factors which determine the water expenditure through the modification of the behaviours of the consumers with respect to the resource (II). Finally, some simple mechanisms can be put in place to ensure an economic and sustainable exploitation of the resource (III).

## **Conceptual Aspects of the Study**

### **The theoretical bases of the economic valorisation of water**

People draw their subsistence from the natural resources. Economic activities are derived from this tension between the needs of the men and the exploitation of the natural resources. Consequently, relations between the commercial sphere (economic sphere), and the non-commercial (environmental) sphere are complex, sometimes confliction. Nature is more a prey to be ransacked than a capital to be preserved. This is why the theorists of the public economy talk about failures of the market with regard to the evaluation of the environmental goods. Indeed, these kind of goods often do not have a price and escape then from any attempt for a monetary evaluation, i.e., escape from the market. Much more, when the prices exist, they do not reflect the total social cost which its production required (Barde, 1992).

Today, people try to reconcile themselves with the nature by being accountant of its management with respect to the future generations: it is the research of the sustainable development.

Studies on the economic and technological aspects of water show that it is difficult to exploit in an efficient way 100 % of the produced hydraulic resource (Hirshleifer and al., 1963). Therefore, one faces a problem of imbalance between supply and demand for water. According to Partnership for the Municipal Development (2003), water losses are estimated at 50 % of consumption. Consequently, the quantity of water available must be rationed. Because of the absence of a property right on a resource like water, conflicts of use on the exploitation are often observed. Indeed, Coase (1960) says the natural resource in general is wasted when the rights of property, the mode of management and access to the resource are not clearly defined. To whom belongs the water resource: to the State or to a private individual? The conflicts of use create an abusive and anarchistic use of the natural resources. The situation has been formalized by Hardin (1968). He showed how it was difficult to reconcile the contradictory interests of the peasants and the herders men on the use of a plain. For the peasants, the piece of ground should be used for the food crops while the shepherds wanted to use the plain as pasture for their animals. It is undoubtedly because of this conflict of use created from the abusive use of the natural resource in free access that authors were brought to affirm that the definition of the mode of appropriation, public or private, constitutes a new stage of the process of "marketing". It is this process of "marketing" which will

enable the “internalisation” of the negative externalities due to the failures of the market of the environmental goods. Because any wasting of the natural resource poses the problem of its availability, a resource available in insufficient quantity and/or quality, generates a modification of the consumer's surplus, and therefore, generates a modification of the well-being of the economic agents Barde (1992); Desaignes and Point (1993).

Thus, the stake of the theoretical debates on the renewable natural resources relates primarily to their modes of management and appropriation.

### **An anachronistic management of water like a good in free access**

One thus realizes more and more that water is not a natural resource available in unlimited quantity. The majority of the countries of Africa and the Middle East suffer from chronic shortage worsened by recurring episodes of dryness Funk (1994). The truth is that water became a limited resource which should not be wasted any more, more especially as a reduction of the needs is improbable. It is consequently advisable to set up a system of management of the cycle of water articulated on a reduction of the use. When water is available, it is wasted because the rights of ownership on the resource are not clearly defined. This situation is more palpable in the rural areas where there are still absolutely free water points placed at the disposal of the populations. Such a situation of exemption from payment leads to a conflictual use of water, each one wanting to draw the best from it. What confirms well the theories of Hardin and Coase described above. Water then seems not to have a price or at most, the price when it exists, does not constitute a sufficiently strong signal to reveal the right value and the invaluable character of the resource.

### **Policy and situation of water in Cameroon**

#### **- *The water policy***

The supplying of potable water and drainage programme of Cameroon opted for two approaches according to whether it is the urban zones or the rural zone concerned. Indeed, in the urban areas, the production and distribution of potable water is ensured by the National Water Company (SNEC) within the framework of a contract of concession with the Cameroonian state. In the rural areas, the Cameroonian State is not implied directly in the supply of drinking water, thus yielding the sector to the Nongovernmental Organizations, some associations such as the churches and the national elites.

#### **- *The state of water***

The interior renewable resources of water per capita and per annum are rather considerable in Cameroon. Compared with the world average of the countries in the process of development and the African area, this places Cameroon in a good position.

**Table 1:** Comparison of the renewable water resources and the rate of access of the populations to drinking water in some African countries

Countries	Renewable interior water resources of countries (in thousands of m <sup>3</sup> of drinking water per capita/annum)	Population having access to drinking water in %		
		Rural	Urban	Whole
Cameroon	19.192	31.3	86.2	50.5
Togo	3.247	41	82	55
Senegal	4.182	44	90	63
Burkina Faso	1.084	37	66	42
Burundi	0.566	49	92	52

Sources: UNICEF, 2003; UNDP *and al.*, 2002; DSCN, 2002.

According to table 1, one notes that in all these countries, the supply of drinking water is more ensured in the urban zones. One also observes a strong disparity between the availabilities of water and the access rate to the resource. Cameroon for example is of all these countries the most provided out of water with 19,192 m<sup>3</sup> per annum but the rate of average access to the resource is hardly 50 %. However, countries like Togo, Senegal and Burundi have rates of access largely above the average. Even a sahelian country as Burkina with hardly 1,000 m<sup>3</sup> of interior resources of renewable water manages to offer water to more than 40 % of its population.

Returning to the case of Cameroon, the resource allocation within the country is also faced with some problems. As table 2 indicates, apart from the Littoral and South-west provinces which are supplied for more than 50 %, all the other provinces have rates of access to the resource under this average. The Centre province (Yaounde area), seat of the republican institutions, contrasts with a weak rate of access to the resource of 22 % and the East province which has the worst rate of access of 13 %. This inequality of access to drinking water inside the country also contrasts with picks of 83.7% and 94 % of access rates to water in the cities like Douala and Yaounde respectively.

**Table 2:** Proportion of the households having access to the drinking water in all the areas in Cameroon

<b>Provinces</b>	<b>Percentages of households having access to the drinking water</b>
Adamawa	40.1
Centre	22.7
East	13.2
Far-North	41.9
Littoral	55.0
North	36.2
North-West	48.4
West	28.7
South	32.6
South-West	75.1

Source: DNSCN, 2002.

## **Socio-Economic Determinants of Water Expenditure**

### **Methodology**

#### **- Data collecting**

To undertake our study, we carried out an investigation relating to the perception of the determinants of the consumption of drinking water on 500 households in Yaounde. The samples were taken according to the percentage of the number of inhabitants of each district in the city. The analysis of the socio-economic determinants which explain water expenditure was made through linear regression technique. This permitted to consider the significant parameters of the model. Taking into account the fact that the variable to be explained, i.e. the monthly average water expenditure, is a quantitative variable and explained at the same time by qualitative (dichotomic) and quantitative variables, the model adapted to the study is that of the analysis of Variance-Covariance (ANOVA).

#### **- Variables of expenditure**

They are composed of qualitative and quantitative variables.

##### *Quantitative variables*

We took into account the “Number of people in the household”, the “number of households that have a direct connection to the water network of SNEC”, “the awareness of the price of a meter-cube of water”, the “average monthly water expenditure”. The other variables that can have an effect on water consumption are the “number of cooking” per week; the “number of baths”; the “number of washing up”; etc.

#### *Qualitative variables*

Income of the head of household: normally this variable should be treated like a quantitative variable. But because of the treatment by interval that we imposed to it, its analysis rather required a dichotomic definition, i.e. 1 for the incomes higher than 100 000 F CFA and 0 for the incomes lower or equal to 100 000 F CFA.

The educational level of head of household: it was to say if there is a link between the educational level of the head and the level of the water consumption.

The type of sanitation: are there traditional latrines or modern toilets in the house, etc?

The standing of housing: The appreciation of the residences is based here on the nature of the material of construction.

The position of the taps: are they located in majority inside or out of the house? This variable makes possible to appreciate the distance to cover till the source of consumption.

The data analysis, resulting from the linear regression, was made through the statistical software SPSS, standard version 10.0.

### **The analysis of the determinants of water expenditure**

Thus, because of a strong multicollinearity between the various explanatory variables of drinking water expenditure, only a few among them have been finally retained for the analysis. Five sources of variations of water consumption then have been identified. The study of the connections existing between these various factors made possible to retain three from them which are very significant: the type of house; the level of income; size of the household.

Thus, the variance-covariance model of analysis:  $Y = \mu + \alpha D_1 + \gamma D_2 + \delta D_3 + \beta X + \varepsilon$

Where Y represents the monthly average water expenditure;  $D_1$  is a dichotomic variable representing the standard housing factor;  $D_2$  is a dichotomic variable representing the level of income of the head of household;  $D_3$  is a dichotomic variable representing the interaction between the type of housing and the level of income; X represents the number of people who live in the

household;  $\mu$  is the constancy;  $\alpha$ ,  $\gamma$ ,  $\delta$  and  $\beta$  are coefficients and  $\varepsilon$  is the error term satisfying the properties of homoscedasticity of variance.

**Table 3:** Presentation of the variables selected

Variables	Identification	Variable nature	Modalities
Monthly average water expenditure	Y	Dependent	Numeric
Type of housing	D <sub>1</sub>	Independent	1 if high standing housing 0 if not
Income of head of household	D <sub>2</sub>	Independent	1 if income above CFA 100.000 0 if not
Interaction	D <sub>3</sub>	Independent	1 for household living in high standing houses and with the income of head above CFA 100.000 0 if not
Number of people in household	X	Independent	Numeric

## Results

### The results of the regression

The regression carried out according to the explained step above gave the results summarized in table 4.

**Table 4:** Results of the regression and level of statistical significance

Variables	Coefficients	t- Student	t-Significance
Housing standing (D <sub>1</sub> )	2871.455	3.099	0.002
Number of people in the household (X)	294.169	3.371	0.001
Income of head of household (D <sub>2</sub> )	1232.180	1.334	0.184
interact (D <sub>3</sub> )	-1291.536	-1.395	0.165
constancy ( $\mu$ )	2265.024	2.081	0.039
R <sup>2</sup>	0.64		
F (Fisher)	11.73		
Sign F	0.000		

Thus the statistical relation  $Y=2265+2871D_1+1232D_2-1292D_3+294X+\varepsilon$ .

(2.081) (3.371) (1.334) (-1.395) (3.089)

From the results, only constancy  $\mu$ , variables X and  $D_1$  are significant with thresholds lower than 5 %. the others, namely  $D_2$  and  $D_3$  being significant only with thresholds higher than 15 %.  $R^2$ , the coefficient of determination, is equal to 0,64. Which means that the average expenditure of consumption is explained to 64 % by the explanatory variables selected. Indeed, this level of  $R^2$  is acceptable in so far as the characteristic of the majority of the studies as ours which the data are collected within a short time on some economic agents like the households, have the characteristic to often result to low coefficients of determination (Griffiths and al., 1993). The statistic of Fisher F is significant at 100 %. This enables us to validate the model.

**Other results**

Some variables that had not been taken into consideration in the linear regression are presented in Table 5.

**Table 5:** Other variables

Variables	Modalities	Values
Knowledge of price of a m <sup>3</sup> of water	Yes	26 %
	No	74 %
Perception on the quality of water	Good	41.3 %
	Bad	58.7 %
Perception of the heads of household on the price of water	Expensive	60 %
	Affordable	27 %
	No response	13 %
Type of water supplying	Water connection at home	62 %
	Public water points	38 %
Educational level of the heads of household and level of average monthly water consumption	No education	F CFA 4166.65
	Primary education	F CFA 4342
	Secondary education	F CFA 4136
	High education	F CFA 4765.625

From table 5, one observes that only 26 % of questioned heads of household are aware of the prices charged by the SNEC. This result shows that although the majority of them (60 %) think that water is expensive in Cameroon, the price level practised does not constitute however a signal on the invaluable character of the resource. The price of water therefore does not constitute a brake in the use of the resource. According to us, such a disinterest in the taking into account of the price of

the resource and more generally on the other determinants of the consumption of water, can be explained by the fact that, this price itself, is not sufficiently indicative to constitute a strong signal on the reasonable use of the resource. As a consequence, the supply of water can be regarded as free in comparison to the prices applied, when compared with other energy supplies like gas, electricity and even heating wood which are also products of the environment.

It is true that for some households, given the precarious economic situation, it is already too difficult to pay water bills. It is also true that at a purely philosophical point, to pay water, a so essential good for life, seems to be abnormal. But most of the invoices relate mainly to the services related to the distribution of water Martin and Fassotte (2000).

The monthly average water expenditure was estimated at F CFA 4,426 for the whole of the households of Yaounde. The average size of the households was estimated at 6 people by household. The heads of household having an income equal or less than F CFA 100,000 constituted 68.67 % of the sample while 62 % of the households had a connection in the house. These households with connection in the house have rather high levels of consumption because of the proximity of the resource and the differed mode of payment of the invoices while 38 % of households are supplied with the paying fountain at the neighbours. Displacement to the fountain and the instantaneous payment of the quantity of water taken can justify the moderate amount of consumption of this category.

In addition, it is noted that the educational level of the heads of household does not have an impact as for the reasoned use of the resource. Indeed, the average amounts of consumption is comprised between 4166.65 and 4765.62 corresponding to the sections of the educational level "no education" and "high education". The perception of households on water quality is rather bad. In fact, 58.7 % of the heads of household think that water supplied by SNEC constitutes a threat for health.

## **Mechanisms of Sustainable Management of Water**

Montginoul (1998) thinks that the sustainable management of water is possible through three essential conditions. First, a legal framework must exist, indicating the top priority, creating and determining the rights of ownership. Then, some tools must be set up to make possible the respect of the legal framework so that it benefits the community. Lastly, these tools must be able to be applied. For that, it is necessary for the community to accept them, the infrastructure must be adapted to the setting (like the existence of meters for a volumetric pricing), and there must be an authority to force the respect of the code (the water police in France for example).

Beyond these general conditions, the achievement of each objective previously quoted requires that we add some other additional conditions.

## **Towards the legal independence of the SNEC: privatisation**

In a general way, the public companies practised administered prices largely under economic tariffs. However, the budgetary transfers became fewer, today States intervenes less and less. What is important today for the public or parapublic companies, is the fact of receiving less subsidies. The production and distribution company of water must become more autonomous and account for its results through a realistic pricing policy. In Colombia and Argentina for example, the privatisation of the sector of water resulted in the improvement not only of the quality of water and the services, but also of the access of the poor to these services World Bank (2004).

According to a UNDP study (1996), in average, households of the developing countries pay 35 to 40 % of what it costs to feed them out of water. They are thus subsidized with nearly 60 %. According to the same study, a great majority of the urban households want to have water and are ready to pay the integral cost on condition that its be of better quality. But in the majority of cases, one could think that people do not have the means of having access to water connection. They have because of this, used the public funds however limited to ensure services of poor quality to a restricted number of people. This situation ends in a vicious circle, a poor service generating a less reserve to pay and conversely, there are the poor people who suffer the most because of application of steps that were supposed to help them. Because they are excluded from the network, they generally pay water more expensive at the neighbour than the really cost of the same quantity of water provided by the network UNDP (1996) and Valiron (1997).

The debate on the privatisation of public services responsible for the production of water is current today in the developed countries as in poor countries. One thing is outstanding; the production of drinking water is a very expensive operation. The profitability of the investments is modest, even in a long run. The resources of the public operators are falling, the administrations, large consuming water do not pay the invoices and the culture of free water on the households leads to wasting. By way of illustration, the water distributors have fixed costs part of ranging between 60 to 80 % of the total costs, whereas the variable costs according to the volume of production constitute a marginal share Trinkwasser (2000). Their infrastructures have to be maintained and renewed independently of water consumption, it would then be necessary to guarantee the financing of the distribution of water at cost price. Of course this can only be made possible through several joint actions at the level of the authorities such as the improvement of the quality of water, the raising of the purchasing power of households, etc. The privatisation of SNEC is on the agenda. Its results could help to change the behaviour of the users with respect to the resource.

### **A price discrimination system**

SNEC practises already a pricing system proportional to progressive sections. Indeed, the price of water is fixed at a given minimum level. Then it increases above. By way of illustration, a

consumption ranging between 0 and 10 m<sup>3</sup> (social section) is currently invoiced<sup>1</sup> at F CFA 271 that is \$ 0.542 per m<sup>3</sup> free of taxes and at 337 F CFA or \$ 0.674 beyond. This means that a maximum consumption of 10 m<sup>3</sup> in this first section is taxed F CFA 271 per cubic meter, which corresponds to an expenditure of F CFA 2710. But, one m<sup>3</sup> of water is equivalent to 1,000 litres. The litre of water provided by the SNEC costs then F CFA 2. 710, that is appreciatively \$0.00542. However, this system does not produce yet the result anticipated compared to the appropriate use of the resource. One could associate others as area price discrimination policy.

The pricing could take into consideration the difficulties to supply water in an area. The price of the cubic meter of water in the South of the country for example, where water is abundant and easy to produce, should not be the same as that practised in the sahelian area of the north province.

### **A campaign of information and sensitisation of the households**

SNEC could educate its customers through television and radio sluts on how the resource could be used properly. It could for example draw the attention of the consumers to the need for locating and repairing quickly the taps and damaged flushing toilets. By way of illustration, a toilet under a shower uses generally more than 40 % of water that is necessary. The use of a saver of jet can reduce two thirds of water consumption in the shower. A 10 minutes bath under shower drops approximately 200 litres of water Infoaeroplan (2004). To also mitigate the discomfort due to the possible water cuts, it is advisable to collect water and store in clean jars.

### **A participative management of the rural communities**

When the rural communities benefit from the construction of a water point, the inhabitants must adopt behaviours which reduce to the minimum the negative externalities resulting from a disordered use of the resource. The community participation thus became a strategic approach in the fight against the effects of obstruction resulting from the free access of the community to resources as water. The objectives of the community participation as regards the rural hydraulic programs consist on the implication of the recipients at several levels :

- the financial or material contribution of the populations to the realization of the water points.
- the technical maintenance of the installations. According to Wagne (2002), more than 60 % of the water points created are currently non-functional because of non-adapted technologies. In Cameroon, Coing and al. (2004) point out the disastrous assessment of many municipal networks of public water points abandoned or closed in the Eighties because of an important amount of non-paid bills by the municipalities to the water company.
- the participation of the community to the definition of programs in their favour

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<sup>1</sup> F CFA 1 ≈ \$ 0.002.

- the local management of income resulting from the exploitation of their projects

These little behavioural concerns on the one hand, and on the other hand, the various pricing systems considered, would reduce the wasting and would encourage a more efficient consumption of the resource.

## Conclusions

It arises from the study that the great majority of the heads of households, that is 60 %, find that water is expensive, while as, 74 % of them do not even know the prices applied by SNEC. Under these conditions, even though a macroeconomic variable such as the purchasing power or the inflation rate is not taken into consideration since we deal with microeconomic variables and the mixture between the two is not easy, we are brought to conclude that the high bills of water are more psychological than real. The price of water is thus, not yet a factor which regulates the consumption of potable water in Cameroon. In the same way, the educational level of the head of household does not have an effect on the rational use of the resource. On the other hand, factors such as the size of the household, the type of house, the mode of water supply (direct connection to the network of the company of water ; or provisioning to the public water points), the position of the taps (taps placed inside and/or outside the house), have a significant impact on the level of consumption of the resource. Therefore, to guarantee a sustainable management of the resource, the actions to be carried out could be concentrated on the acceleration of the privatisation process of SNEC (Nkengfack, 2006). This change in the legal status can generate a more autonomous management of the structure. One could also apply a discriminate pricing policy to areas to take into account the accessibility to the resource. In the same way, at the individual level, some behavioural concerns by each user would make it possible to reduce the wasting which is incompatible with the sustainable use of water. In the rural areas, the participative management of water points is highly encouraged.

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