Journal of Sustainable Development in Africa (Volume 10, No.3, 2008)

ISSN: 1520-5509

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ECONOMICS OF WATER, HEALTH, AND HOUSEHOLDS' LABOR MARKET PARTICIPATION IN CENTRAL AFRICAN ECONOMIC AND MONETARY COMMUNITY (CAEMC) COUNTRIES: THE CASE OF CAMEROON

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Abstract

In Cameroon, access to potable water has been an issue of public concern. The Cameroonian State is conscious of the importance of water as a basic necessity of life. Therefore, it is determined, with the assistance of many world organizations (World Bank, World Food Organization (WFO), etc.), to improve people's standards of living through increased access to potable water. Restricted access to safe drinking water leads to poor living conditions, and sometimes to absolute poverty. Better access to potable water supply systems reduces the time hitherto wasted in the process of getting drinkable water, the cost of health care, and the cost of reduced labor productivity resulting from diseases. It can also produce direct economic benefits and, therefore, improve living standards. Our study uses primary data drawn from the 1996 ECAM household survey in the local government areas of center province, Ngaoundere, North and Far-North, in Cameroon. The data were analyzed using simple statistical and econometric methods, specifically the multinomial logit model. Our results show that the value of time associated with water collection and the health impact of unsafe water is often substantial. Saving such time may translate into greater labor market integration, better income, increased welfare, and a smooth escape from the web of poverty.

Introduction

Millions of people all over the world, particularly in developing countries, are faced with a daily crisis in the process of obtaining water for their basic needs. Specifically, more than 3 million people are without access to uncontaminated water supply and an unknown, but highly significant, percentage also have to spend hours daily collecting water (Olufunke, 2001; Briscoe & de Ferranti, 1988; Churchill, 1987). Briscoe (1984) has estimated that family members often spend from 3 to 5 of their daily prime productive hours searching for water.

In Cameroon, access to potable water has, for a period, been an issue of public concern. The Cameroonian state is conscious of the importance of water as a basic necessity of life. It is, therefore, determined with the assistance of many world organizations in charge of water (World Bank, World Food Organization (WFO) etc.) to improve people's standards of living through increased access to potable water.

According to Olufunke (2001), improved water systems are an important factor in improving the lot of the poor; more convenient supply systems will significantly influence the time spent by women and children sourcing water. Saunders and Warford (1976) documented a mix of economic losses and benefits to different water conditions in a number of places. Few of the documented examples integrate the case of lowland Lesotho, where about 25 percent of households spend over 180 minutes per day collecting water (Feachem et al., 1978). In East Africa, households spend up 5 hours per day carrying water (White et al., 1972), while households in North Cameroon spend up to 6 hours per day collecting water (National Institute of Statistics Cameroon, 2004). The government in Cameroon was so concerned about the water situation that it had to provoke commitment by lower levels of government in initiating possible relief measures.

For those who may be concerned about the implication of the above proposal on the poor, evidences from the literature established that it is erroneous to affirm that households, specifically the poor, cannot pay for improved water services. For instance, in a case from Lima, Peru, Briscoe (1984) and Adrianza and Graham (1974) reveal that many poor people are already paying substantial amounts of money for even poor quality water supply systems.

In Lima, quantity used even from poor quality service was 24 litres, while the household's monthly expenditure for that volume was 106 soles (Peruvian currency). While medium quality service constitutes 80 litres per capita per day of household's consumption at an average monthly household expenditure of 20 soles. Also, good quality service contributed 150 litres per capita per day at a monthly average of 30 soles.

Evidences from many cities in Africa countries reveal that the poor, who do not have access to the public water supply, even pay higher to private water vendors than the higher income groups who are connected to water mains. With such emerging facts, the justification for unpreparedness to pay user-charges for improved access may be baseless. Because of its adverse consequence for income, health, and quality of life of individuals and households, extensive efforts have at one time or the other been channelled by policy markets, governments, and donor agencies towards solving the water problem.

Non-existent or poor access to clean drinking water leads to poor living conditions. Improvement in such access, on the other hand, reduces cost of curative health care and loss of labor productivity possible from these diseases. This can also produce direct economic benefits and, therefore, improve living standards. Many women in African countries transport water by foot over a long distance, which is very hard and time consuming (up to 20 percent of their time) (Olufunke, 2001). Meanwhile, with better access closer to their homes, substantial time spent carrying water can rather be used in a productive manner for other income earning activities.

Increased access to potable water and better sanitation is of fundamental importance for alleviating poverty, especially for women, for the environment, and for public health. A serious concern for poverty alleviation and health is that water shortages put great pressure on third world mothers, and constitutes a serious barrier to the implementation of Primary Health Care (PHC).

According to the world water policy standard, a minimum of 21 litres per user per day is necessary. This must be available within a maximum walking distance of 500 metres. Even the United Nations Conference on sustainable human development (called the: "Earth Summit") recommended an action plan which seeks to increase the minimum access to water per urban dweller to at least 40 litres, while a special water supply program is recommended for rural communities. This, for many developing countries, is a great task. In Cameroon, access to potable water is far below the recommended minimum standard stated above. There is a great variety of water supply systems in Cameroon. Apart from relatively uncommon in-house connections and often dried public stand pipes, use is made of open wells, springs, streams, pools, rivers, and lakes, systems which provide no protection against pathogens and other contaminants, not to mention the substantial time often wasted in obtaining such unhealthy water.

An issue of concern however, is that only little empirical evidence exists on the value people actually place on improved water services and the time it takes for hauling water, specifically in Cameroon. It is, therefore, necessary for studies to evaluate various costs and benefits involved in existing water supply systems.

Access to safe drinking water remains a crucial problem confronting developing nations today and tomorrow. Even when water is available it is often unfit, and this has several health problems. Currently, water shortages are threatening the economies and health of 75 countries. More so, over 1.8 billon people are affected by diseases caused by unsafe drinking water, and a child dies of water-related diseases every ten seconds in developing countries (Esiri, 1999).

Even though the water problem is very serious in African countries, it is also alarming to the entire world itself. The world fresh water supply is dwindling every year, and within 30 years, 80 percent of the Africa population will have problems finding enough water for drinking (Oldfield, 2003; Blanchson, 2003). An estimate indicates that more than 1.5 billion people in the world today lack access to adequate supply of safe water for household use, and if something is not done, in 40 years, as many as 6 billion people may live in areas suffering from moderate to severe shortage of water resources (UN, 1998).

Potable water is still almost elusive in many parts of Cameroon; the water problem exposes people to the dangers of water-borne diseases and death traceable to contaminated options, primarily due to the scarcity of safe drinking water. In Cameroon, about 20,000 people die each year from diarrhoea caused by water borne pathogens (Statistics of Ministry of Mines, Energy and water, Cameroon, 2004). People are often forced by circumstances to fetch water from burst pipes, inside dug out holes and gutters, and other unhygienic places.

In many parts of Cameroon, acute shortages of water make families and communities spend a substantial part of their income and productive time looking for water, and in most cases in distant places. In many instances, difficulty in getting water is so great that any improvement will have significant effect on the time and energy of the people. Despite this, water-resource users often shy away from realistic reconciliation of costs and benefits associated with alternative policy choices. The fact, however, remains that improvement in water supply services is a potential channel for improving household income, national income, and the living conditions of the people.

The water decade declared by the UN is about two decades old, and while much has been accomplished in some countries, much effort is still needed in Cameroon, thus re-emphasizing the urgent need to find sustainable and replicable ways of bringing clean water to urban and rural communities.

There are two options for improving access to water: one is to continue treating water as a public good; the other option is to encourage private participation in water provision. However, despite the public and international agencies' policy focusing on this problem, the situation in Cameroon seems degenerating and, therefore, demands increased attention. Time loss in the process of collecting water in many parts of the country remains very high and the impact on labor supplies, specifically in the informal sector, is still an issue of concern.

The fundamental objective of this paper is to measure the economic impact of various sources of water supply to households, and to encourage households to choose between improved water sources based on economic losses and gains associated with alternative water supply systems. Specifically the study includes: identification of major determinants of households' willingness to use particular sources of water supply; estimation of the magnitude and value of time spent collecting water from different supply systems; examination of the impact of various categories of water on the health and income-earning prospects of rural and urban households in Cameroon; and investigating household characteristics and water use in rural and urban Cameroon.

Cameroon is endowed with abundant water resources; the country has about 18 billon cubic metres of renewable water annually (Cameroon is one of the countries in the world where large amounts of water are supplied by rainfall each year).

The net advantage of improved systems is very significant to households; they must, therefore, be ready to pay however small amount of money. Although a number of studies are based on the benefits derivable from improved water services, they tend to emphasize the biological aspects of the gain. A study is, therefore, necessary to determine the gains and losses resulting from various sources of water in Cameroon. It is important for studies to determine the sustainability or otherwise the public-good conception of water supply. Therefore, direct economic gains are still less understood and are being investigated, except in terms of health and the economic benefits of investing in good water systems; hence, the gap which this research intends to fill.

In addition to the introduction, the study is organized as follows: section (2) literature review and conceptual framework, section (3) methodology, section (4) data collection procedures, section (5) discussion of results, and conclusion in section (6).

Literature Review and Conceptual Framework

There is literature on the economic theories of household attempts to analyze the complex structure of households and their behavior. As Olufunke (2001) implies, information on the demographic structure, decision-making process, resources allocation, income earning mechanisms, and labour market characteristics is a prerequisite for understanding the consequences of specific programs linked to household welfare. But, various factors determine the sources and the quantity of water household members are ready to use at a particular point in time. These factors are explicitly discussed in a number of studies, especially in the World Bank (1994) study. We think that these determinants are very important for planners of water resources.

Review of literature: One of the major tasks of water resources planners, includes integrated the determination of the propositions of households that will opt for a given level of service at a given set of prices, the welfare consequences, and the multiple effects on economic growth and development. Thus, the traditional microeconomic theory postulates that households choose quantities of goods and services that maximize their utility. Solution to such a maximization problem is, however, subject to constraints imposed by prices and the household income. The income variable is influenced by the household labour market participation, which in turn affects the time available to labour market and non-market activities.

According to the World Bank (1994), three sets of factors jointly influence a households' willingness to use, or to pay for improved systems of water supply. These include: (1) the socio-economic and demographic characteristics of households, that is, education of family members, size, occupation, measures of income, composition of the family, expenditure, and assets; (2) the household's attitude towards public policy in the water sector, and their sense of entitlement to public services; and (3) the characteristics of the existing or traditional sources of water and those of improved water supply systems, including the cost, the quality, and the reliability of the source. The response of a household to a new, improved water supply system is not due to any one of the set of these determinants alone, but their joint effect (Mu et al., 1990).

According to a study by Olufunke (2001), there are variables, such as income and asset, education, gender, occupation, family size, and composition, which are considered as the most important socio-economic and demographic determinants of household demand for improved water supply services. The result shows that willingness to use and pay for a particular (or rather an improved) source of water services does not depend solely on income, but also characteristic of both the existing and improved supplies. This means that very often income is not even the principal determinant, the percentage of income that the households are willing to pay may vary widely. In the case of East Africa (Kenya, Uganda, etc.), households were already paying water vendors 7 percent of their income, while in the North Cameroon area, many households pay water vendors about 8 percent of their income.

Sydney and Jeffery's (1999) empirical findings further confirm that educational status plays a key role in the household behavior about specific sources of water. In Cameroon, six years of education increased household's willingness to pay for both public taps and private connections by about 40 percent. In Brazil, a family in which the head of household had completed middle school increased the probability of connecting by an additional 12 percent. An increase in educational level according to the study of World Bank (1993) had smaller effects.

Equally important is gender sensitivity to the water issue. It was recognized that the number of women in a household affects the pattern of water use because they bear more of the burden associated with water collection. The effect of occupation on the willingness to pay indicates that rural families in Senegal place less value on improved water than urban households.

According to the study of Haile (1981), factors such as family size, education, income level, and cultural heritage were re-emphasized. Other factors were: characteristics of water supply, distance from the sources, and cost of obtaining water, as measured by energy or cash expenditure, terrain, and climate.

As for the determinants of the sources, other authors (Viroulon, 2003; Smith, 2000; Plancq-Tournadre, 2006) consider factors such as costs in time and money, perceived quality, and reliability of services as part of the determinants of household choice of a water service system. The cost variable was motivated by the basic theory of consumer behaviour, which suggests that households would pay more for improved systems when the costs in time and money of obtaining water from existing sources are higher than if such costs were low. Households living near perennial streams would pay only one third the prices paid by the villagers living farther away from their traditional sources.

The demand function for water indicates that reduced collection time affects the quantity of water consumed (Mu et al., 1990; Olufunke, 2001). Long distance discourages the frequency of collection and extends the storage period, which in turn increases the likelihood of exposure to contaminants, as does carrying water over long distances (Hoddinott, 1997). Increasing the quantity of water available has a nutritional impact. It permits greater frequency of food preparation, thus reducing the tendency of consuming contaminated food products (Esrey & Habicht, 1986). Cairncross and Cliff (1987) explained the impact of improved water systems on the allocation of time. In World Bank (1994), empirical results supported the expectation that households would also be more willing to change if their traditional source is poor. According to Haile (1981), for most rural people, any water is safe to drink.

Robinson (1988) found that the health impacts of unclean water sources are not unnoticed. There are various diseases associated with unsafe water (water-washed, water-based, water-borne diseases, etc.). These diseases impact directly upon household productive time, productivity, and general household welfare. So, reliability of service is very crucial.

The case of the Eastern and Northern parts of Cameroon reveals that households were already spending a lot of money in the dry season purchasing water from tanker truck vendors and neighbors. Most households are spending 3 to 6 percent of their income per semester buying water from vendors. Generally, time is a scarce resource.

Becker (1993; 1999) and of Olufunke (2001) agreed that one of the most important contributions in the development literature is the introduction of the time variable in households' decision process. An interesting aspect is that, while available goods and services may increase, available time does not; consequently, demand remains unsatisfied, and as individuals and households strive to increase welfare, time becomes more valuable.

According to Becker (1965) and Bergstrom (1997), the household production function clearly uses some aspects of the theory of the firm (specialization, human capital, comparative advantage, etc.). In the 1960s, economists started to view households as a factor in the production process. As a production unit, a household, combines capital goods, raw materials, and labor to clean, feed, procreate, and otherwise produce useful commodities. So, in the household production function, time, market goods, and services combine to produce basic commodities or non-market goods; however water access and health also contribute.

Some studies (notably, Chippaux et al., 1993; Brockeloff, 1995; Hoddinott, 1997) have examined the impact of water systems on variables that determine the health status of household members. Most of the studies assumed that an improvement in quality and increased water quantity will have a direct effect on people's health through reduced exposure to water-born diseases, and an indirect effect through improved ability to consume complementary commodities that also enhance health.

Better access to water reduces time hitherto committed to sourcing water, for if effectively directed to the labor market time will increase income, which may translate into greater consumption, and hence, improved health. Similarly, better health increases income from wages and agricultural activities; directly through wages and the farm production function, healthier individuals increase their effective hours of wage earning and farm work.

According to Martorell (1995), the impact of poor access to water cuts across ages, and has lifelong consequences. The loss of stature in infancy leads to loss of the same in adulthood. Such retarded growth is associated with premature mortality due to increased risk of obstructive lung diseases (World Bank, 1993). More importantly, small stature is also associated with loss of income at adulthood and low birth weight at reproduction.

Of studies that examine the implications of various sources of water on household health and income issues, only few studies attempt the empirical estimation of different water sources on household income and further income-earning potentials (Hoddinott, 1997). Hoddinott estimated the annual cost of dracunculiasis (or Guinea worm disease) in the Central Africa Republic as 8,000 CFA francs per patient, 11 percent of the average worker's income.

It is unfortunate to note that there is a dearth of studies on the quantification of the impact of various sources on health and adult income earning capacity or on the number of hours committed to the labor market.

From a policy perspective, it is worrisome that the full economic implications of improved water systems are yet unknown in Cameroon. It will be a desirable contribution if the likely economic impact of additional resources committed to reducing travel time and improving the quality of water supplies can be determined with a high degree of success.

Therefore, analysis of economic effects on improved access to water, and studies that explore the labor market consequences of such intervention represent an area on which research will provide a valuable insight.

Conceptual frameworks: Water is a good that has both a consumption value and, in certain circumstances, values derived from external benefits for those who do not directly consume it. In theory, the benefit derived from a private good are fully divisible and excludable, and the benefits of public goods are indivisible and non-excludable (World Bank, 1992). Industrial water is a private good, but residential water can supply external health benefits and is, therefore, neither a purely private nor public good. On the spectrum of private to public goods, residential water lies between the two extremes, and probably closer to pure private goods.

The major issue of concern to donor agencies and policy makers is the negative impact of sub-optional water-policy designs on the health and productive capacity of members of households. Perhaps an interesting way to begin a study like this one is to consider the conceptual framework set out in a similar study by Hoddinott (1997), which was an extension of a study done by Behrman and Deolalikar (1988).

Adoption of this framework may rightly enable us to capture the influence of improved water access on the health and income earning potential of households. In reality, maximization of household's labor market earnings requires that it solves the price dependent utility function.

In Hottentot's framework, with useful inputs from Behran and Deolalikar (1988), and Fortin and Laccroix (1997), household preference is represented by the following utility function:

$$\text{Max}U = [H^i, C^i, T^i, L^i] = U^i(H^i, C^i, C^p, T^i)\,] \quad (1)$$

$$\text{Subject to } \sum_{i=1}^{n} W_i T_l^i + \sum_{i=1}^{n} y_i \geq C^i$$

Where, households seek to maximize their utility function (specified in the above equation) subject to family budget constraint, which is made up of the family's labor market income. In the above equation H^i is the health of the i^{th} individual within the household; C_j^i is the consumption of j sets of commodities by the i^{th} individual; C^P represent the household's consumption of public goods; and T_l^i is consumption of leisure by i. These four sets of variables represent a medium through which the household can maximize its utility at that moment. This function can, however, be maximized subject to a number of constraints, which include the health, water, wage, and labor market production functions. It also includes time and full income constraints.

Hoddinott (1997), states these functions as follows; the health production function was given by:

$$H^i = h(C_j^i, C^p, T_l^i, E^i, T_h^i, W^i, \rho^l, \Phi) \;\; i = 1,......,1 \quad (2)$$

Where, E^i is the educational levels of individuals within the household; T_h^i is the time spent by i producing health; W^i is the consumption of water by *i*; ρ^l is innate health endowment; while Φ is a vector of community characteristics that include other variables that affects individual's health.

For the water production function:

$$W^i = w(w, T_w^i(D^w), E^w, C^{wc}, E^m, A^w, H^i, \Phi) \;\; i = 1,......,1 \quad (3)$$

In this instance w represents the quality of water available to the households; T_w^i is the length of time spent by *i* and other members of the household collecting water, this assumed to be a function of distance from homes to the sources of water (i.e.; D^w); E^w is the knowledge of good health, as it relates to water collection or storage; C^{wc} are complementary commodities used in domestic purification of water; and A^w constitute capital goods, such as buckets and pots used in transporting and storing water. Where households can choose among several sources, w and D^w become choice variables.

The third constraint is a wage function, represented as:

$$P_L^i = P_1(H^1, T_L^i, C^i, E^i, \rho^i, \theta) \; i = 1,.....,l \qquad (4)$$

Where, P_l^i is the wage person *i* receives for participating in the labor market, and θ is a vector of characteristics of the labor market.

The fourth function in this framework is the labor market output (farm and non-farm) function:

$$Y^h = Y(H^i, C^i, E^i, T_L^i, A_F) \; i = 1,......,1 \qquad (5)$$

And finally, the time and the full income constraints given by:

$$T^i = (T^{iL} + T_h^i + T_w^i + T_L^i + T_f^i + T_{wc}^i) \; \forall \, 1 \qquad (6)$$

Where, T^i is the time spent by *i* in wage work. Note that T_{wc}^i is a function of distance to such complementary goods, such as distance to source of firewood, and decontaminants. Based on the specifications above, households total income function is expressed as:

$$P_y.Y^h + \sum P_L^i.T_L^i + R = P_A A + \sum P_w.W^i + P_{wc}.C^{wc} + P_P.C^P + \sum_{i=1} \sum_{j=1} P_{C_j}.C_j^i \qquad (7)$$

Where, P_s are prices of commodities and assets (described above), while R represents exogenous incomes. It is hypothesized that improvement in water quality and quantity will positively influence health and labor market participation. The line of argument is that there is a significant level of risk of health interruption from an unguaranteed water quality, which may affect income earning capacity, if not outright interruption of labor supplies (Hoddinott, 1997).

Methodology

Two complementary methods were considered in this study; the first being the analysis of survey outcome through statistical procedures; the second uses econometric methodology, as used in a similar study by Whittington, Mu, and Roche (1990).

The methodology takes into account various factors, which affect choice decisions in sourcing water. A complete model of households' source decisions posit that the utility a household derives from a water source is a function of at least two sets of explanatory variables: (1) source attributes which affect household's utility; and (2) households characteristics which reflects differences in tastes and preferences among households. Let us start by making "X" a vector of source characteristics, and "Z" a vector of household characteristics. The conditional indirect utility function of household "h" may, therefore, be written as:

$$MaxU_{it} = U_{it}(X_{it}, Z_{it}) \tag{8}$$

Subject to $\sum W_i T_1^i + \sum Y_1^i \geq C^i$

Where, i is a water source, and h denotes households. Since utility, U_{it}, is not directly measurable, researchers attempt to estimate the utility, U_{it}, from the observed independent variables, X_{it} and Z_{it}. Such approximation of U_{it} will, however, be subject to error and, as a result, some inconsistencies in observed behavior are inevitable. According to random utility theory, such unobservable or immeasurable influences are assumed to be captured in a random term, which for operational purposes, is usually assumed to be added to the observed (systematic) term in the household's random utility function (Manski, 1973; Ben-Akiwa & Leman, 1985; Whittington et al., 1990). In our example, the random utility function is stated as:

$$U_{it} = V_{it} + e_{it} i \in j \tag{9}$$

Where, V is the observed term, and e is the random term. Let the variable, y_{it}, stand for the household *t*'s choice decision on source, j, such that:

$$y_{ih} = \begin{matrix} 1..if V_{jt} + e_{jt} \succ V_{it} + e_{it} \\ i, j = 1 \\ 0..otherwise..i \neq j \end{matrix} \tag{10}$$

The expected value of y_{it} is thus:

$$E(y_{jt}) = P(yt = 1) \tag{11}$$

$$= P(U_{jt} \succ U_{it}) \tag{12}$$

$$= P(V_{jt} + e_{jt} \succ V_{it} + e_{it}) \tag{13}$$

In other words, the probability that household t chooses alternative source j equals the probability that the utility derived from using j is greater than any other alternative (Amemiya, 1981; McFadden, 1973, 1982). Based on the random utility framework, the following utility function for household *h* choosing sources i was postulated:

$$U_{it} = V_{it} (T_w, C_p T_s H_h Y, WOM, E^i) \tag{14}$$

Where, T_w is the total time spent collecting water per day (minutes per day); C^p is the total cash paid for collecting water (in terms of price by volume); T_s is the household's perception of taste (equal to one if the taste is poor and zero, otherwise; H_h is the time lost to water-borne diseases by both the sick and their caretakers (it includes time spent ensuring the health of household members); Y is the total annual income; WOM is the number of adult women in the household, and E^i , the educational levels of family members.

Since the distribution of U_{it} depends on the distribution of e_{it} , different assumptions about the distribution of e_{it} will lead to different discrete choice models. Here we assume that e_{ih} has a Gumbel distribution, so that the probability of choosing a source will have a logit-type function (Ben-Akiva & Lerman, 1985). Note that the independent variables in the random utility function, which describe the source attributes, vary across sources; the independent variables, which describe the household's socio-economic characteristics, do not vary across sources (but are included just to explain variations in tastes across households). The standard statistical method for dealing with the first group of independent variables is a logit model; the standard approach for the second set of independent variables is a polychotomous model. McFadden (1973, 1976, 1982) and Maddala (1983), have developed the following conditional logit model to deal with data structures which include both groups of independent variables:

$$P_t(j) = \exp(\beta X_{jt} + \alpha_j Z_t) / \sum \exp(\beta X_{it} + \alpha_i Z_t) \; i=1 \tag{15}$$

Where it is assumed that the households function is additive:

$$V_{it} = \beta X_{it} + \alpha_i Z_t \tag{16}$$

The purpose of presenting this discrete choice model is to be able to derive the estimate of the value of time spent hauling water (Whittington et al., 1988). We can obtain this by first estimating equation (16). After obtaining the coefficient of the explanatory variables, we can estimate the value of time spent hauling water using the coefficient of T_w (time) and C^p (cash) committed to a particular source. Such value is defined as the marginal rate of substitution between the time spent collecting water and money paid for the water, and can be calculated from two of the estimated parameters of the conditional multinomial logit model. The value of time spent is simply given by the ratio of coefficient $\beta_1 m$ to β_2 (estimated coefficient of time, health, and cash, respectively). This may be calculated as:

$$\text{Value of time (per minute)} = (\beta_{1m} / \beta) \qquad (17)$$

Where, m is the coefficient of time spent collecting water, T_w, and time spent on the health of the members of households, H_h.

This is expected to give a significant insight into the value households place on time spent collecting water, and the health implication of different supply sources.

Statistical Data

This study adopted the ECAM 2001 description of a household as consisting of all members eating in the same spot and slept under the same roof during at least six of the last 12 months. The divisions (or provinces) used in the ECAM 2001 survey is the Center province, Ngaoundére, North, and Far-North. Sampling was based on population density classification as this gave a stable, reliable, and more comparable estimate of the water situation in each of the local government areas.

There were four provinces used in the study in Cameroon; four towns were randomly selected from a sample ECAM 2001 classification, namely, Yaoundé, Ngaoundéré, Garoua, and Maroua. Sampling was based on a population density classification, as this gave a stable, reliable, and more comparable estimate of the water situation in each of the local government areas. Other criteria employed in the construction of the sample frame included the Centre province health zonal system and its local government into urban and rural areas. Also, due to the pathetic division of water supply at the household level and more importantly, due to the trend in water-related, water-borne, water motivated diseases these areas were selected.

The ECAM 2001 data presented findings on a number of issues associated with the water used in some selected rural and urban areas in Cameroon. The focus of the data research was motivated through looking at the characteristics of different sources and their implications on household's time, health, current income, and prospects for future income. Various facts about the water situation in ECAM 2001 data for urban and rural areas are presented below in five aspects. Before analyzing the five aspects, it is important to note the structure/components of the households in our respective areas of study; the average family size in urban and rural areas are 6.8, and 12, respectively; and as one may expect, the household size in rural areas are quite larger than that of urban areas, respectively. (What usually accounts for this is the consideration for potential consideration of additional children to the rural labor force.)

Sources of water and their implementation for household health: Different areas are open to different types of water supply systems. The range varies across urban and rural communities. The field shows that different systems of supply have variously different quality, and have different implications for individuals and households in their use of the sources. For instance, many of ECAM 2001 respondents rated in-house tap, boreholes, and public pipes very high in terms of quality in areas where such systems operate. Table 1 (below) shows that in the urban areas, over 75 percent of the respondents, who use in-house connections, rate such systems high in terms of quality. Samples were subjected to various quality tests, such as color, turbidity, and odor (physical characteristics) as indicated in the Federal Water Pollution Control Administration, Washington, 1970.

Table 1: Water Supply Systems, Quality, and Level of Use and Health Implications in Urban Areas

Sources	Quality rating by respondents (%)		Access per type of sources (%)	Cases of illness per source	Cumulative Length of Illness (days)
	good	bad	Sample size= 149		
In house	75.7	14.3	20.5	2	16
Tap	80.5	3.6	34.2	3	13
Borehole	83	-	1.1	1	11
Public pipe	64	27	49.1	9	115
Unpiped well	57	24	4.8	0	0
Neighbours	66	23	3.2	0	0
Spring water holes	-	-	-	-	-
Stream/Pond	-	-	-	-	-
Water vendors	98	0	14	2	-
tankers	0	0	0	0	0

Sources ECAM2001, 2001

In the urban areas of Cameroon, where one expected in-house connections to be the regular water supply source, only about 23 percent chose that source which was supposed to be most convenient; the most commonly used source (based on Table 1) is the unpiped well. About 44 percent of the urban population is using the unpiped well, making that system the most accessible source, even in the urban areas. Next to the popular option, in the urban centers surveyed is the use of borehole, the system that services about 34 percent of the urban samples. According to the statistics, 14 percent of the population uses expensive, but well rated, water vendors. The use of public standpipes in the urban areas is very insignificant, as less than 1 percent of the urban samples were familiar with the use of such a system. The reason for a low proportion of the populace who uses in-house connections may not be so far fetched; the unreliability of what was meant to be the major source of urban supplies system informs the current trend in capital investment on water (boreholes, unpiped well, etc.) availability in the urban areas. It may take time before people are convinced and yield to probable re-orientation towards in-house connections as the major-source.

When rated in terms of quality, the water vendor system was rated as the most qualitative (98 percent) even though it costs a fortune. The borehole was rated at 80.5 percent in terms of quality, followed by in-house connections rated at 75.7 percent, and public standard pipes at 66 percent. The difference in quality rating between in-house connections and public standpipes may be due to the distance and storage involved in that system. In terms of sickness, associated with water-borne diseases, most of the sick in this respect use unpiped wells (Table 1).

The dimension in the rural areas is rather more pathetic. Most of the people (at least 70 percent) in rural areas use streams and ponds, which were rated 98 percent poor in terms of quality. The second most accessed alternative was unpiped wells, which were also rated poorly in terms of quality (Table 2). Public boreholes were a common sight in few of the villages. It is, therefore, not surprising that 185 of the people sampled were ill from water diseases, while both the sick and the people taking care for them lost 8,412 days.

Table 2: Water Supply Systems, Quality, and Level of Use and Health Implications in Rural Areas

Sources	Quality rating by respondents (%)		Access per type of sources (%)	Cases of illness per source	Cumulative Length of Illness (days)/Hh
	Good	Bad	Sample size = 130		
In- house tap	0	0	0	0	0
Borehole	93.2	5.6	32	57	59.5
Public pipe	97	0	8	6	22
Unpiped well	10	88	45.8	53	1625
Neighbours	0	0	0	0	0
Spring	19	81	4	7	168
water holes	0	100	3	0	0
Stream/Pond	2	98		98	4300
Water vendors	98	0	8	0	0
tankers	89	11	9	11	112

Sources: ECAM2001, 2001

Effects and Costs of Water-Motivated Diseases: It is not particularly surprising for people living in areas of relative water scarcity to experience different types of water-associated disease. What is so pathetic is the extent of loss due to water-caused diseases, especially, in the rural areas. The economic burdens of diseases far outweigh whatever investment on water one may consider across households. In the literature, water-associated diseases are classified under the following titles: water-borne diseases, which include Cholera, Typhoid, etc.; water-washed diseases, such as scabies, skin sepsis, Trachoma, etc.; water-based diseases, involving dracunculosis (Guinea worm) and schistosomiasis; and water-related vectors that dwell in areas where water holes and co-become breeding places for vectors. We adopt the same classification in this research.

In terms of effect, more people experience water-borne diseases in the rural areas in respective magnitudes than the urban dwellers. Out of the surveyed households, 67 were ill of water-borne diseases in the rural areas and 14 were affected in urban places. More work days were lost in the rural areas, though the cost of medication is higher in urban areas, followed by the high town. The reason for spending more in urban areas can be due to the fact that urban dwellers are more frequent in seeking medical attention than the other groups when ill. The result of the ECAM1 statistics revealed that the second group of diseases (water- washed diseases) is not common in the urban areas; it is, however, more pronounced in the central Africa areas, but the time loss and average cost of care per round is higher in the rural area dwellings.

The second category of diseases is relevant to the rural dwellers alone. The number of households affected and the magnitude of loss are the greatest of all considerations in the ECAM1 statistics. According to the ECAM1 statistics, the diseases under the second group affected only 22 people in the sampled community, with each round of Guinea worm lasting an average of 103 days per effect.

The above trend does not seem surprising when one considers the kind of water mostly used by the respective classes of people. Most urban dwellers commit more money to making potable water available to them as possible, while in the rural areas any water is useable. According to Table 3, the rural sector is most affected due to the nature of water being used.

Table 3: Percentage Trend in Water-Associated Disease by Area

Area	affected	Total number	Percent
Urban	22	149	12
Rural	79	127	59.2

Source: ECAM1, 2001

Intensity of Water Use per Source: Table 4 shows that despite the fact that unpiped wells are more frequently used, due to the availability, in-house running taps are used more in terms of volume, when available in the urban areas.

Table 4: Intensity of Water Use by Source (Number of Buckets used per day)

Sources	Number of Buckets Used per day Sample Size: Rural = 127: Urban = 149 Rural Households	Urban Households
In house-tap	0	27
Borehole	11	18
Public pipe	7	10
Unpiped well	9	14
Neighbours	0	10
Spring	10	0
water holes	7	0
Stream/Pond	11	0
Water vendors	5	3
tankers	30	0

Source: ECAM2001, 2001.

An estimate of 27 buckets of in-house tap water is used per day in urban households, while 18 buckets from the borehole system are used in rural households. The increased use of the tanker system in the rural areas is simply due to the nature of the jobs these people are engaged in. Most of the respondents in this category were poultry farmers, which may account for such volumes of tanker water. In the rural areas, it was discovered based on the ECAM 2001 survey, that the combination of unpiped wells, stream/ponds, water holes, and springs (which were qualified as poor on Table 3 above) show that more buckets are sourced from these systems per day than from credible sources.

Education of the Household and Willingness to Pay for Improved Systems: Like in many countries in Africa, education is an important variable for determining the willingness to pay for an improved service system, including Cameroon. Valuation of various sources, and more importantly an improved access system, differs across levels and demographic characteristics of the target. As for the uneducated, 33 percent of the uneducated indicated that they were not ready to pay for any level of improvement. At the other extreme, we observe that about 45.5 percent of rural households are mainly poultry farmers, who are heavy users of water. Looking at the uneducated in the urban areas, there was an indication of readiness to pay for water, no matter how small the amount. The ECAM 2001 data reveals that the bulk of the people that are reluctant to make commitment, in terms of possible payments in case of improved access, were from the rural areas. One may say that the effect of urbanization may have affected people's orientation to the use of goods that can easily pass for a public good. On average, Table 5 (below) shows that willingness to pay improves with the levels of education. The effect of education on the households' willingness to pay for improved services is more significant in the urban areas; the rural statistics do not show consistency in terms of valuing improved services by levels of education. This may tend to agree with the notion in the literature that any water is drinkable in the rural areas (Olufunke, 2001).

Table 5: Education and Households Willingness to pay for improved Water Systems (by Areas and by Levels)

Range FCAF	Tertiary education %		Extension education %		Technical education %	
	Rural area	Urban area	Rural area	Urban area	Rural area	Urban area
Nothing	25.1	4.1	0	26	18	6.8
Less than 50	7.9	32.2	0	0	0	6.9
50 -100	10.4	7.1	19	0	0	6.6
100- 150	10.5	1.4	17	0	0	0
150- 300	14.7	35.0	41	53	18	13
300- 500	8.8	13.1	7.7	23	61	16.7
above	28.7	7.7	12	0	0	52.6

Source ECAM1, 2001.

Table 5 also shows that out of the two geographical areas, the urban area shows more consistencies with the literature, that is, the data generally conform to the notion that willingness to pay for improved water increases with the level of education.

Education of Household Heads and Household Preference for Water Systems: The results of the survey show that the more educated the people are, especially in the urban areas, the more likely they prefer improved water systems. On Table 6, for instance, over 64% percent of people, who have tertiary education, use in-house water connections.

Table 6: Education of the Household Heads and Preferences for various Sources

	Various Water sources							
	In-house		Bore-hole		Public pipe		Un-piped/well Stream/pond	
Education	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural
No schooling	2.8	0	0	27.0	0	0	6.8	21.4
Primary	2.6	0	0	9.2	0	100	10.0	13.7
Secondary	15.5	0	17.2	8.8	32.3	0	25.8	16.8
Tertiary	64.0	0	74.7	14.3	34.0	0	41.0	23.0
Technical	18.2	0	4.4	2.5	0	0	12.2	1.9
Extension	0	0	1.7	41.5	32.4	0	3.4	13.7
others	0	0	0	0	0	0	0	15.8

Education	Stream/Pond		Spring		Water holes		Neighbours		Tankers		Water Vendors	
	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural
No schooling	0	29	0	59	0	50	26.0	0	0	51	0	0
Primary	0	10.0	0	21	0	24.5	13.2	0	0	0	16.0	0
Secondary	0	2.7	0	21	0	24.8	13.3	0	0	0	31.8	0
Tertiary	0	17.7	0	0	0	0	38.2	0	0	12	43.0	100
Technical	0	3.9	0	0	0	0	0	0	0	42	8	0
Extension	0	19.2	0	0	0	0	13.6	0	0	0	0	0
others	0	0	0	0	0	0	0	0	0	0	0	0

Source: ECAM1, 2001

Looking at Table 6, one would realize that people, with at least secondary education in the urban areas, don't use poor quality sources, such as stream, ponds, water holes, etc. At all levels of education, no household in the rural area had the opportunity to use in-house connections. This is understandable, due to absence of such facilities in the rural sector. The use of unpiped wells also increases with rise of the levels of education in all sectors (Table 6). Tanker services were mostly used in rural areas probably due to livestock farming. Otherwise, people with reasonable levels of education (at last secondary school) constitute the bulk of persons that uses neighbor and water vending systems.

The time, distance, and monetary cost associated with various water supply systems influence household preferences, especially where alternatives are available. Survey data confirm the fact that the poor in rural areas are already paying higher prices (time, distance, and cost) in the process of obtaining useable water, not necessarily potable. The rural people go through greater pressure than any other sector.

Table 7 shows that, apart from the initial investment and probably monthly payments for in-house connections, it involves no additional cost in terms of money, distance, and time. On the other hand, unpiped wells, which are popular in urban areas, consume an average of 20 minutes for household members to obtain water, in addition to the initial capital outlay for digging wells.

Table 7: The Cost of Obtaining Water by Households from Various Sources

	Average distance (metres)		Average Time (minutes)		Average Cost (FCFA)	
Sources	Urban	Rural	Urban	Rural	Urban	Rural
In house	0	-	0	-	0	-
Bore hole	27	115	15	45	0.5	0.8
Public stand pipe	10	75	40	155	0.2	0
Unpiped wells	235	480	17	115	0.08	0
Stream/Ponds	0	900	0	120	0	0
Springs	0	98	0	170	0	0
Water holes	0	52	0	70	0	0
Neighbours	18	0	45	60	0	0
Water vendors	25	0	15	30	1.8	0
Tankers	0	0	0	0	0	0

Source: ECAM1, 2001

The same source in the rural areas took an average of 480 minutes of the household members for a single, round trip. Streams and ponds, which were rated poor also, took as much as 115 minutes of household member’s time per round trip hauling a bucket of water. Streams in the rural areas were located as far as an average of 900 metres from homes. Cost, in terms of actual cash, is not significant in our results. The opportunity, cost of time, and energy expected on just a round-trip of water is very significant.

Considering capital investment on water, urban households invest an average of about 38,867 CFA francs, while the rural household, who enjoy less, however, committed as much as 18,692 CFA francs on water-related capital investment (Ngongang, 2004). In urban and rural areas, many people suggested that if it agreed with them, they were capable of providing water to all the households at no cost.

Discussion of the Results

The results of the model estimation are presented in Tables 8 and 9 (below). The variables, time and cash, which are used in determining the value of time, are both significant at 1 % level. We present the results of the models for urban and rural areas below. The variable time here is defined as the marginal rate of substitution between the times spent collecting water and the money paid for the water. This is determined from the estimated parameter of the multinational Logit model. Specifically, it is the coefficients of time and costs that determine the value of time spent collecting water by the households. Also, the ratio of length of time spent being ill, as result of water-associated diseases and cash paid by households for water, is used to determine the value of time lost as a result of such illness. The models are formally presented for urban and rural areas in Tables 8 and 9 below.

Tables 8: Results of Model of Urban Households' Water Source Choice

Model dependent Variable: HMSWS	Unstandardized coefficients	Unstandardized coefficients	t-ratio	Significance.
	Std-Error	Beta		
Constant	0.390		3.544	0.000
THTCW	0.000	-0.300	-4.580	0.000
THCSGW	0.001	0.571	-9.222	0.000
NPH	0.012	0.29	0.499	0.598
THT	0.000	-0.048	-0.699	0.440
QWT	0.211	0.200	3.260	0.001
TLIH	0.009	0.000	-0.137	0.799
HHE	0.051	0.090	0.158	0.776

Log-likelihood ratio = - 43.0; Chi-squared = 0.000

****Note:** THTCW = Total household time used in collecting water; THCSGW = Total household cash spent on getting water; NPH = Number of people in the household; THT = Total household Income; QWT = Quantity of water (taste); TLIH = Total length of illness (household); HHE = Household head education; HMSWS = Households' major sources of water supply

To estimate the value of time spent collecting water, and the value of time lost to sickness, associated with unsafe water, as specified in equation 10, we obtain the following:

Value of time

A. collecting water $= (\beta_1/\beta_2)$

$= (-0.390/-0.665)$

$= 0.5864$ per minute

= 15. 89 CFA per hour.

B. length of sickness $= (\beta_6/\beta_2)$

$= (-0.0011/-0.665)$

$= 0.001654$ per minute

= 0.99 CFA per hour

Table 9: Results of the Model of Rural Households' Water Source Choice

Model dependent Variable: HMSWS	Unstandardized coefficients	Unstandardized coefficients	t-ratio	Significance
	Std-Error	Beta		
Constant	0.124		9.646	0.000
THTCW	0.000	-0.490	-3.140	0.001
THCSGW	0.017	-0.579	-6.400	0.000
NPH	0.002	0.032	0.433	0.701
THT	0.000	-0.001	-0.011	0.909
QWT	0.019	0.513	4.590	0.000
TLIH	0.001	-0.011	-0.150	0.833
HHE	0.018	0.049	0.659	0.510

Log-likelihood ratio = -30.2; Chi-squared =0.000

****Note:** THTCW = Total household time used in collecting water; THCSGW = Total household cash spent on getting water; NPH = Number of people in the household; THT = Total household Income; QWT = Quantity of water (taste); TLIH = Total length of illness (household); HHE = Household head education; HMSWS = Households' major sources of water supply

To estimate the value of time spent collecting water and the value of time lost to sickness associated with unsafe water, we obtain the following:

Value of time

A. Collecting water $= (\beta_1 / \beta_2)$

= - 0.256/- 0.599)

= 0.4273 per minute

= 200 CFA per hour

B. Length of sickness $= (\beta_6 / \beta_2)$

= - 0.015/- 0.599

= 0.02504 per minute

= 1.233 CFA per hour.

The models are significant in explaining the relationships between the two sides of the equations. Our exploratory variables show expected signs, and the two variables, time and cash, which were used in our determination, are significant at 1% level. Our result shows that the value of time spent collecting water is highest in the urban areas and lowest in rural. The results indicated that an hour spent obtaining water by an urban household is worth 0.4273 local currency values. Also, the value of the same loss by a rural household translates to about 2.00 CFA, while it is 1.233 CFA only in rural areas. For the health aspect, the value of time spent taking care of the sick is equally significant among rural households. Based on deductions from Table 6, an hour spent by any member of the household on water-associated diseases or taking care of the sick by other household members, translates into 1.123 CFA in the rural areas and 0.4273 CFA in urban areas (Ngaoundere, Garoua, Maroua).

Looking at common sources of water supply by areas, one may deduce from previous data analysis, that urban dwellers use more of in-house-taps, boreholes, and piped-wells, while unpiped wells are widely used in rural areas. Rural dwellers mostly use the sources of water that were widely classified unsafe, such as streams, dug-out- holes, springs, etc., usually from distant places; the implication of which is discussed in the next section.

The results justify substantial investment in water by urban dwellers. Many of the urban residents sampled were connected to water mains, while many invest heavily on bore-holes and piped wells. Loss of productive time by urban households in search for water has serious implications for their ability to earn income in the labor market. This justifies the trend obtained on Table 5 and Tables 1 and 2, where urban households mostly used the sources that were rated safest in our statistical analysis. With the sources widely chosen by urban households, the incidence of water-associated diseases is largely unheard of. However, with wider access to a more functional in-house connection, urban dwellers that already cherish safe and more convenient systems of water supply may save more time, and even scarce resources. The magnitude of the estimated value linked to time spent on water, revealed that for households in this category, investment in better access is small compared with the labor market income they stand to lose to inefficient time allocation.

Although rural households pay virtually nothing to obtain water, they spend prime time, and the most valued part of their day, searching for that water, the quality of which has serious implications to their health. Access to better facilities will go along way to improve the welfare of rural dwellers, and probably could take them out of the web of poverty.

Functional and better water systems would increase household productive hours, give them better opportunity to earn income, and reduce the psychological stress associated with hauling water. Looking at the health implications of unsafe systems, it is quite obvious that rural households are loosing substantially to unsafe access to water. A careful linkage of costs, in terms of the monetary value of time, to Table 3 shows that the conservation of time loss into illness, in local currency, is substantial. In the rural areas, the average length of a simple incidence of water-associated diseases in rural households is as much as 40 days. If we take time to convert the days into hours and money, it means a lot in terms of relieving the poor.

Conclusion

This study investigated the costs of time spent searching for useable water, and the water-associated diseases in urban and rural areas. The study was based on the methodology used by Whittington et al. (1990) and by Olufunke (2001). We used the multinomial logit model in determining the value of time. The study selected areas, based on the local government classification of areas, into urban and rural. The results show that substantial resources are often lost daily searching for water in those areas, and particularly in the rural sector of Cameroon. Also, the statistical analysis indicates that there are substantial economic losses associated with the water situation in Cameroon. We can safely conclude, based on this analysis, that support for better systems is worthwhile, given the fact that people, including the poor, are already paying more for unsafe systems. With substantial time saved from various sources, more goods can be produced, more money can be made, and the welfare of people could be enhanced.

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