Water Demand Management and its linkage to Economically Weaker Social Group (EWSG): An analysis of Basic Issues and Perspectives

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Abstract

Water Demand Management (WDM) offers an alternative to conventional thinking about water resource management, by influencing changes in behaviors, policies and practices of water users and promoting more efficient, equitable and sustainable use of existing water resources from a multi-disciplinary and multi stakeholder perspective. In order to justify the above issues, we have set our analysis in the framework of Economically Weaker Social Group (EWSG).

Our objective is to show how WDM can contribute to improve the economic condition of the EWSG by improving the economic condition by reducing poverty defined in terms of strengthening opportunity, equity, security and empowerment. These will require restructuring of water sector operations and proper management reforms in the Water demand.

Since our objective of contrasting WDM with Economically Weaker Socially Group will call for introducing qualitative as well quantitative variables, for example when we shall talk about opportunity, equity, security, empowerment etc, we need to construct qualitative variable and for this we shall use logit model,

Findings:

1. Water Demand Management may be an alternative to exogenously augmenting supply without considering effective demand.

2. Economically Weaker group use water more economically efficient way.

3. Water Demand Management reduces water wastages and thereby increase the economic viability of water supply system itself.

4. Providing water supply through better water demand management leads to cost effective way to provide water supply to a large number of people with more sustainable manner.

Key words: *Water Demand Management, Water Price, Economically Weaker Social Group, Water sustainability*

Introduction

Economically weaker social group are economically weaker in terms of economic parameter. It may be in terms of monthly per capita income (MPCI) criteria, monthly per capita expenditure, or poverty line. (Here we however, is taking monthly per capita income (MPCI) criteria as the defining parameter of economic weakness) The EWSG are broad group. It consists of four subgroup according to their nature of habitation, namely group living at slum, group livings in jhupri, groups living at shanty, others, who are not coming into either of this three group but living in pucca structure, but coming under economically weaker group. It has been assumed all the persons living into slums, jhupris and in shanties are economically weaker social group.

In this paper we have tried to bring up the issues that are related with interaction between EWSG and of water supply in terms of health, education and basic amenities.

The interaction

How the EWSG interact with the society in terms of water supply can be sketched out with this picture. Takes for example a typical individual who belongs to EWSG. The day begins with the rush for lining up for water collection. In Kolkata and most of the places at Kolkata suburb, people do not have to walk much to collect water. One will find a community tap nearing to their residence. Thus problem is not the distance but the queue when they get to the tap. Access to clean drinking water in Kolkata, a city of over 10 million people is erratic at best. At worst poor people can go for days without a steady supply of water. At that time they disperse desperately for water to nearby or distant source like ponds, tanks, water storage. This desperation and suffering for water are not only making nuisance in terms queuing, but it is affecting their economic life, social life as well. The impact of this is incalculable. The education of the children is affected, as they do not have time to go to school. Relationships suffer within the family. Arguments frequently broke out with neighbors on the issue of collecting of water, its timing and amount. Work hours is lost due to being late for breadwinner and other member of the family who are engaged in some or other petty or casual job. Often they are being sacked or get less wage due to late coming to work.

The EWSG groups lack access to basic urban services generally, but the poor are particularly badly served by public water supply and sanitation (WSS) systems. While domestic water and sanitation services are frequently subsidized, most of the subsidy benefits go to the urban non-poor. Furthermore, the poor have very little leverage to get things changed and so are forced to endure the current system and make the best of the situation, with resultant implications for their health and well-being. Ironically the much-quoted subsidies are ineffective and tend to perpetuate the inequitable treatment of the poor and disadvantaged members of society. The very limited services available to this section of society means that they frequently have to find other means of getting water and have high associated monetary and time costs. This results in higher costs per litre of water for the poor as compared to the middle income and wealthy – even more so when related to their disposable income.

Apart from these, water-washed diseases are prevalent in areas with inadequate water supplies for people to keep their hands, bodies and environments clean. Diarrheal diseases as well as skin and eye infections are easily spread under these conditions. Water-borne diseases transmission occurs through the consumption of contaminated water, and can affect those illness transmitted by the faecal-oral route including diarrheas.

Within these perspectives, we can now formalize the interaction between EWSG with the society in terms of water supply in the following manner. We, however, restrict our area of study within Kolkata Municipal Corporation boundary.

Water availability (As on 2001-02)

Surface water (PWW)	180 mgd
Surface water (GWW)	40 mgd
Ground water (power driven tubewell)	30 mgd
Ground water (tubewell-hand)	10 mgd
Total	260 mgd

Here we can note that there are 11,000 stand-posts within KMC boundary and total discharge of water through them is 18.5 mgd, (out of which 9.0 mgd are wasted).

If we define those with monthly per capita income less than Rs. 1000 belongs to EWSG, then according to the socio-economic survey conducted by CMDA during 1997-99, the 74 percentage of whole population within the KMC population belongs to EWSG. Among these group, 32.5% population belongs to slum population. Since most people belongs to EASG do not have individual in-house water connection, hence most of their water dependency hinges towards stand-post. Therefore we can take the total availability of surface and ground water for EWSG are 18.5 mgd

Water availability for EWSG 18.5 mgd

Water Requirement > Accessibility

The survey conducted under the World Bank Project No. P.O 50648 Kolkata Water Supply Sewerage and Drainage Project indicates that water requirement for the slum is 15 gallon per capita per day (gpcd)

The project team has conducted a survey of detail daily water use. It revealed the facts are as follows

Table-1: Household Requirement per person per day

	Requirement	**Total requirement per person**
2 showers per person per day:	@20 litres per use	40 litres
4 uses of WC per person per day	@ 14 litres per use	56 litres
6 hand/mouth wash/person/day	@ 2 litres per wash	12 litres
Drinking water/person/day	@ 3 litres	3 litres
Washing clothes/persons/day	@ 40 litres	40 litres
Cooking 3 meals per family (5 persons)	@ 10 litres per meal	6 litres
Washing utensils per family of 5 persons	@ 35 litres per day	7 litres
Floor wash for family of 5 persons	@ 30 litres/day	6 litres
Other requirements:		
Watering plants	50 litres	
Car washing	20 litres	
Campus washing	30 litres	
Water requirement for family of 5 persons for other requirements	100 litres	20 litres

Wastage & misc. @ litres per capita		10 litres
	Total	**200 litres =44 Gallons / capita / day**

Table-2: Slum Requirement per person per day

	Requirement	**Total requirement per person**
2 showers per person per day:	@10 litres per use	20 litres
4 uses of WC per person per day	@ 10 litres per use	40 litres
Drinking water/person/day	@ 4 liters	4 litres
Washing clothes/persons/day	@ 15 litres	15 litres
Cooking 3 meals per family (5 persons)	@ 10 litres per meal	4 litres
	Total	**83 litres =15 Gallons / capita / day**

Accessibility

The EWSG may get affected in terms of accessibility of water supply in the following aspects:

- Changing land use / conversion of water bodies
- Removal of road side tap or stand-post or tube-well from renovation or construction of new road project or flyover or any other infrastructural construction
- Drying of tube-well due to decrease in ground water level
- Pollution of water bodies
- Inadequate services for the poor

Water consumption

Actual water consumption depends on a number of factors. First the actual water consumption will depend upon how much water they can collect. Since

EWSG do not have money to store water. Hence their water consumption will depend upon how much water is available at their nearest source. The second thing is that accessibility. Nowadays water supply authority is more eager to supply water in bulk to big housing complex for sake of higher revenue, as a result of that stand-post supply and individual household supply get affected, and supplied water amount is shrinking day by day.

There are 11,000 stand-post within the KMC area, which are distributed over 141 wards. The sample survey for the stand-post was conducted in 38 different wards to measure the flow, observe the usage pattern and also estimate the wastage of water through them. In conducting the above survey, representative locations were chosen from three water supply zones viz. North, South & Central zones. In most of the observations were taken twice i.e during high & medium pressure supply, observation was taken once. During each such observation, several measurements of flow through the stand-post were noted over specified period and then flow calculation was made for average flow for that specified pressure supply.

It has been estimated that out of Total flow of water of 18.5 mgd, the consumption of water from standpost is estimated to be 9.5 mgd

Total Stand Post 11,000

Total flow of Water 18.5 mgd

Total Consumption of Water 9.5 mgd

Payment for water

Use of water supply for domestic purpose:

Premises connected with 10mm diameter ferrule = Rs. 28.00 per annum

Premises connected with 15mm diameter ferrule = Rs. 120.00 per annum

Premises connected with 20mm diameter ferrule = Rs. 480.00 per annum

Premises connected with 25mm diameter ferrule = Rs. 780.00 per annum

Premises having single connection of 10mm diameter ferrule are expempted for water fees as mentioned. If the premises has more than one connection then usual fees are to be paid for 2nd connection. Premises having 20 mm diameter or 25 mm diameter ferrule are required to pay annual water fees as mentioned.

Ferrule sizes are determined on the basis of annual valuation of the premises

More than Rs. 9999.00 = 25 mm

More than Rs. 4999.00 = 20 mm

More than Rs. 1200.00 = 15 mm

More than Rs. 1200.00 = 10 mm

Slum dweller, shanty or jhupri dweller do not pay anything for use for water supply. But remaining section of EWSG who dwells in the *pucca* structure and whose premise is coming under above structure have to pay for water. The general approach to tariffs for the poor implies low service levels with an almost free service. For example it is common to provide standposts and common toilets in low-income settlements with near free charges. Similarly, there are subsidies available for meeting the infrastructure charges for service networks within slum settlements. However these subsidies are inadequate to fund the service levels required, and are generally not combined with community resources effectively to provide more sustainable levels of services in these settlements.

Nowadays in some part of Kolkata, particularly in southern part KMC, due to non-availability of good quality of water, there is a strong demand for good quality surface water. Capitalizing this want, a section of EWSG has taken up water vending as their means of livelihood. Water is selling at the rate of Rs. 7 to Rs. 15 per litre. This is a new dimension of interaction, where EWSG earn some money, capitalizing the inadequacy of quality surface water.

Table-3: Household Water Requirement (Non-slum) per person per day

	Requirement	**Total requirement per person**
2 showers per person per day:	@20 litres per use	40 litres
4 uses of WC per person per day	@ 14 litres per use	56 litres
6 hand/mouth wash/person/day	@ 2 litres per wash	12 litres
Drinking water/person/day	@ 3 litres	3 litres
Washing clothes/persons/day	@ 40 litres	40 litres
Cooking 3 meals per family (5 persons)	@ 10 litres per meal	6 litres
Washing utensils per family of 5 persons	@ 35 litres per day	7 litres

Floor wash for family of 5 persons	@ 30 litres/day	6 litres
Other requirements:		
Watering plants	50 litres	
Car washing	20 litres	
Campus washing	30 litres	
Water requirement for family of 5 persons for other requirements	100 litres	20 litres
Wastage & misc. @ litres per capita		10 litres
	Total	**200 litres =44 Gallons / capita / day**

Table-4: Household Water Requirement (Slum) per person per day

	Requirement	**Total requirement per person**
2 showers per person per day:	@10 litres per use	20 litres
4 uses of WC per person per day	@ 10 litres per use	40 litres
Drinking water/person/day	@ 4 litres	4 litres
Washing clothes/persons/day	@ 15 litres	15 litres
Cooking 3 meals per family (5 persons)	@ 10 litres per meal	4 litres
	Total	**83 litres =15 Gallons/capita/day**

Water Demand Management:

Water demand management (WDM) involves actions and sound methods to push the community in the direction of an appropriate use of water thus reducing water consumption by the final user and, at the same time, incrementing new consumption habits that would bring no impairment to comfort and hygienic necessities as provided by existing systems (USEPA, 1998). Then, water demand management goes beyond consumption management: rather than a question of organizing consumption data and of building graphics, WDM insists on studying these data and on guaranteeing the system feedback (Lins & Riberio, 2007)

The need for urban water demand management measures, which includes public policies for stimulating household water consumption efficiency, exceedingly justifies the development of researches that can indicate paths to address this objective. Within this context, this work aims to analyze an important requirement in order to succeed in performing an effective and sustainable water management system is having a sufficient knowledge about households water demand. This study aims at identifying the determinants of the households' choice of drinking water source. The multinomial logistic regression model is used for discrete analysis of source choice. Data needs for empirical analysis are secondary data from a survey conducted in 2007 by the water resource etc. A cross-section of 11391 households was interviewed. Our findings show that distance to the water source (proxy of time cost) affect households' choice. Thus, the longer the distance to a particular source of drinking water, the lower will be the demand for same. Our study also confirms the fact that households' characteristics such as the household size and the household expenditure (proxy of household welfare) have a strong impact on the choice of drinking water source.

Water is a basic need for human life. It is used daily for many purposes: industry, agriculture and domestic use. According to the World Bank (World Resources, 1996), 69% of the 3240 Km3 of fresh water drawn every year are used by farmers, 23% by industrial sector and 8% for domestic use. Today, the right to water is increasingly recognized universally as a fundamental and inalienable right of the human person. Though essential for human life, access to drinking water (note 1) represents a day to day struggle for hundred's and thousand's citizens who live mainly in developing countries (Herischen, Ruwaida, & Blackburn, 2002 ; Chapitaux, Houssier, Gross, Bouvier, & Brissaud,2002 ; UN-Water/WWAP, 2006). In this regard and according to the World Health Organization (WHO), nearly 1.1 billion of individuals (17% of the population word-wide) do not have access to drinking water. Until today, waterborne diseases represent a real public health problem in many countries: 1.8 millions of people (90% are less than 5 years old) die every year due to waterborne diseases like cholera, mainly in the developing countries (WHO, 2005). Furthermore, 21% of infant mortality in the developing countries (DC) is caused by diarrheic diseases (UN-Water/WWAP, 2006). This will inevitably decline the attainment of sustainable development since health is regarded as the pillar for sustainable development.

The population's access to safe water supply is a real problem. Less than 30% and 40% of the population have access to potable water in urban and rural area respectively. As it is the case in most of the ward, only a small fraction of the population is connected to the pipe network. Besides, connected households face day to day consequences of a deficit in the water supply: water is not supplied round the clock and pressure is insufficient to pump. For many years now, the government has considered population access to safe water supply as a top priority. It is sets to 75% the objective of access to potable water supply in 2020. This is consistent with the Millennium Development Goals which aims at reducing the proportion of people without sustainable access to safe drinking water by 50% by 2015. In order to attend such objectives, the government intends to rehabilitate in the upcoming years existing infrastructures made the overwhelming majority over 20 years, to make extensions of existing networks that have not kept pace with urban expansion and demographic, and to promote the implementation of programs of connections large scale. These actions could not be successful if they are not coupled with a good management of the demand side. Unsuccessful results observed through the world after the first International potable Water and Sanitation decade show the importance of a household water demand analysis. In fact, in spite of the important public investments dedicated to water infrastructures in developing countries during the 1980 decade, it was obvious to observe that people's access to reliable water did not noticeably improve. This is because everybody was focusing on a quantitative objective of increasing households' connection to the public water network, rather than laying the emphasis on the households' water behavior and this situation gives rise to over budgeted infrastructures, far from being appropriate to the needs of the population and inefficiently managed (Breuil, 2004). This reveals the limits of the classical supply driven-approach which is based essentially on the supply side and neglects the demand side. Today, World Bank experts contend, governments need to adopt a "demand-driven approach" in which utilities "deliver services that people want and for which they are willing to pay" (World Bank Water Demand Research Team, 1993). Thus, to ensure that both water systems are sustainable, so that access to safe water is sustained for all, it is necessary to investigate the structure of the demand users.

The identification of the household's choice of water source is a precondition necessary for the implementation of any effective and sustainable policy aiming at increasing households' access to safe water (Briand, Nauges, & Travers, 2009). It is relevant to stakeholders when making water management decisions. This study therefore investigates the behavior of household water demand in Cameroon. The study identifies specially the determinants of households' choice of drinking water source. To our knowledge, there is no empirical analysis of such household choice for Cameroon. It would be awkward to transpose results obtained in others countries here. The study thus contributes to the existing literature by providing an empirical analysis of household choice of drinking water source in Cameroon. Data needs for empirical analysis are secondary data from the households sample survey conducted in 2007 by National Institute of Statistics. The remainder of the paper is organized as follows. Section 1 provides a brief overview of empirically related work. Section 2 presents the background of the study area. Section 3 presents the main methodological issues. Section 4 presents the empirical results, section 5 concludes.

Literature review

Access to clean drinking water is one of the most important precondition for sustainable development. The meta-analyses of Esrey et al. (1991) and Fewtrell et al. (2005) suggest that safe drinking water supplies do reduce the incidence of diarrhea. Thus, it is important to understand the factors that affect household choice of water source. Sustainable management of drinking water requires knowledge of the factors which affect the households' water demand. Economic literature suggests that the choice of water source is commonly influenced by households' socioeconomic and demographic characteristics and by the price of the water. Some empirical studies have been conducted in DC on the choice of water supply. Based on a review of the existing literature in DC on the topic of household water demand, Nauges and Whittington (2010) indicate that existing papers have studied household choice of water source, either as a primary focus (Mu, Whittington, & Briscoe, 1990; Madanat & Humplick, 1993; Hindman, 2002; Briand et al., 2009) or in combination with estimations of conditional water-demand models (Larson, Minten, & Razafindralambo, 2006; Nauges & Strand, 2007; Basani, Isham, & Reilly, 2008; Cheesman, Bennett, & Son, 2008; Nauges & Van Den Berg, 2009). In this second group of studies, a separate estimation of the selection (i.e., source of water) and levels (i.e., water volume) equations is made. It allows for a control of the relationship between households' characteristics and type of access to water sources. The two-step procedure corrects for selectivity bias through inserting a proxy variable (a correction term known as the inverse Mills ratio) to capture the selection effect as proposed by Heckman (1979). Next, we will focus on the first group of studies since they only focus on household choice of water source like the present study.

Mu et al. (1990) use in their model, data collected by in-depth personal interviews with 69 households in Ukunda (Kenya). The estimation of the multinomial logit model suggests that household's decisions are influenced by the time it takes to collect water from different sources, the price of water and the number of women in a household. Household income, however, did not have a statistically significant effect. Madanat and Humplick (1993) extended the work of Mu et al. (1990) in two ways. On the one hand, their study is usage-specific whereas Mu et al. analyzed the choice of water source apart from its use. On the other hand, they jointly analyses households' choice of water sources and connection decisions. Thus, they use two types of models: a binary logit model for household piped water connection decision and several multinomial logit models for the choice of water supply source. The above models are estimated with data coming from a survey made on 588 households' sample of Faisalabad in Pakistan. Next to Pakistan, Asthana (1997) uses a conditional logit model to examine household choice of water supply for households in rural India and finds negative impacts of distance on source choice. Hindman (2002) conducted a study on household water choice in Philipines. He analyzes the effects of water prices, taste (it is use as a proxy for income) and household size on the probability to choose a specific water supply source. A survey was conducted close to 769 households of Cebu to estimate the discrete-choice model used. The results indicate that the time taken to collect water from different sources (proxy of water price) has a statistically significant effect. Household size only affects demand for connection while taste has ambiguous effects on household choice. Using data on 301 households of Dakar (Senegal), Briand et al. (2009) estimate a bivariate Probit model to explain household's decision to rely on a private water connection at home or/and to get water from the public standpipe. The bivariate probit model takes in consideration the fact that there is interdependence between household's decision to rely on a private water connection at home or/and to get water from the public standpipe. The findings show that the household head status (being a widow) as well as the quality of the supply service have a significant impact on households' choices. Findings also indicate that the household welfare, the education of household head, time cost, access to alternatives sources, are strong determinants of household decision to rely on private connection and/or standpipe.Nketiah-Amponsah, Woedem, & Senadza, (2009) use multinomial logit model to identify socioeconomic determinants of household source of drinking water in Ghana. The study uses data from a survey conducted in three Districts (Lawra, Dangme West and Ejisu-Juaben) in Ghana (A cross-section of 531 households was interviewed using stratified random sampling technique). The results confirm the influence of factors such as income, residence (rural or urban), education level of the head and the distance between the residence and water source on household choices. Briand and Laré (2010) explain the choice of household connection to the water network of informal small scale operators in peripheral districts of Maputo (Mozambique). They hypothesize that household access to different sources is exogenous since alternative sources are chosen when the small scale operators do not offer any network, in neighborhoods that are neglected in any way by the official operator. Moreover, households are found most often dissatisfied with the supply alternative sources. The estimation of the probit model suggest that the following variables have a significant and positive effect on the demand for small scale operators' netwoks: education of the household head, household wealth index, proportion of the households in the district who are dissatisfied with the water price, as well as the dummy variables representing the districts of Cumbeza, Albazine, Magoanine B, and Khongolote. Variables having a significant and negative sign are: proportion of the households in the district who are dissatisfied with the water cuts, dummy variables representing the districts of Guava, Nkobe, 1er de Maio, Zimpeto, MatolaGare_Km15_Matèque. The occupation of the household head (farmer=1) and the household occupation status (tenant=1) also have negative and significant signs

Methodology:

We use multinomial logit (MNL) model to investigate the decision made by the households for different water sources. This model is applicable because the dependent variable, sources of drinking water has more than two categories with no natural ordering, representing the different options households have in terms of access to drinking water. The MNL model has proved useful for describing household choice of drinking water and has been used in several studies (Nauges & Strand, 2007; Mu, et al., 1990). The most frequent specifications for source choice models are the probit model and the multinomial logit model (Nauges & Whittington, 2010). The probit model has been used when the household choice being modeled is whether to acquire a private connection or not. Multinomial logit model has been use for describing either the primary source of water chosen by households or the water source that is chosen for a specific use such as drinking, bathing, or cooking. Household choice can be formalized as follows:

Suppose the unobserved variable Y^*_{ij} is the ith household's utility if the household i choose source j. If we suppose that each household choose the optimal water source which brings the highest utility level, the observed choice of the household i for source j can be expressed as follows:

$$Y_{ij} = 1 \text{ if } \quad Y_{ij}^* > Yik^* ,\ j \neq k$$

$$Y_{ij} = 0 \text{ if not} \qquad (1)$$

$$Y_{ij}^* = Y(\ X_i\ \beta_j) + \varepsilon_{ij} \quad \text{is a linear function} \qquad (2)$$

i = 1, 2,..., n is household indicator while j =1, 2,...,m correspond to supply sources. J=1 corresponds to private tap, j=2 corresponds to collective tap, j=3 corresponds to resellers of piped water, j=4 corresponds to public water fountain point and borehole, j=5 corresponds to improved dug well, j=6 corresponds to unimproved sources (lake, unprotected well, stream ...). For further purposes of the study, we removed from the sample the households relying on the following sources: mineral water, rain water, and other. They only represent 0.8% of the survey households. β is a vector of parameters, ε_{ij} is the error term.

X is the vector of following explanatory variables:

Hsize It is the household size and equal to the number of family members.

Edu This variable is the education level of the household head. It is a dummy variable equal to 1 if the household head is literate and 0 otherwise. The a priori expectation is that educated households are more sensitive to the quality of water issues and that is why they are expected to have a high propensity to rely on improved sources. Nauges and Van Den Berg (2009) confirm this a priori expectation.

Sex It represents the household head gender. This dummy variable is equal to 1 if household head is female and equal to 0 otherwise. Briand et al. (2009) find that the gender of the household head is a strong determinant of household choice of water source.

Resid represents household residence area. It is also a dummy variable equal to 1 if household lives in urban or semiurban area and 0 otherwise.

Lexp It is the log of the household per capita average expenditure. This variable is used as a proxy for household welfare. Household expenditure is generally viewed as a better welfare proxy than income in DC (Basani et al., 2008). Expenditure is more stable than income and is a better proxy for permanent income.

Dist is the distance existing between the water supply point and the residence. It is used here as a proxy for time cost. It is expected to negatively influence household decisions (Sandiford, Gorter, Orozco, & Pauw, 1990). Data about distance to water source are not available for many households in our database. For this group of households, we consider the average distance of the enumeration group they belong to.

Price is not taken in this study as explanatory variable because households in Cameroon generally have the same price schedule.

Under the assumption that error terms ε_{ij} are independent and identically distributed, the above probability function can be written as follows:

$$\text{Prob}\ (Y_i = j) = F_{ij}\ (X_i\beta_j) = \frac{e^{(x_i,\beta_j}}{1 + \sum e^{(x_i,\beta_j}} \qquad (3)$$

Where Fij is the logistic distribution function. By implication, we suppose that the independence of irrelevant alternatives hypothesis is repected. The above function is estimated by maximizing the following Log Likelihood function:

$$\text{Log L }(Y, \beta_1, \beta_2, \beta_3, \ldots\ldots\ldots \beta_n) = \Sigma\, \Sigma\, s_{ij} \log [\text{Prob }(Y_i{=}j)$$

$S_{ij}=1$ if $S_i=j$ and 0, otherwise

Under certain conditions, the Maximum Likelihood method provides consistent and efficient estimates of the parameters β (Grenne, 2003 and Amemiya, 1985).

Empirical Results:

Descriptive statistic of explanatory variables:

Data needs for empirical analysis are secondary data from the third households survey conducted in 2007 by the National Institute of Statistics. A Cross-section of 11391 households was interviewed. Descriptive statistics on household demographics and socioeconomics, and distance to water source are summarized.

66.2% of the households live in urban or semi urban area while 33.8% of the survey households live in rural area. On the total, 26.7% households head are female. We observe from our database that the number of family members varies from 1 to 43. Households with one family member are the most important group of the sample (16.6%). A typical household of Cameroon has 4.55 family members. Concerning the education level of household head, data reveals that majority of the households head (76.5%) are literate while 23.5% (2680 households head) are illiterate. Of the literate households head, 32% has primary school level, 1.2% has post primary school level, 35% has secondary school level and only 8% has high school level. About per capita annual expenses (use as proxy for households welfare in our study), we note that it varies from Fcfa 72053 for the poorest households to Fcfa 11300000 for the richest households. Finally, the distance from household residence to the water supply point varies from 0 to 92Km. After some adjustments done for households with incomplete data as mentioned in the sub-section above, it comes out that the average distance to drinking water supply point is 2.77 Km.

Descriptive Statistics:

Table-5

Variable	Mean	Std Deviation	Minimum	Maximum

Resident	0.6618	0.4731	0	1
Sex	0.2673	0.4425	0	1
Hsize	4.5571	3.1052	1	43
Edu	0.7627	0.4254	0	1
Lexp	4726664	487563	72053	11300000
Dist	2.7706	8.2699	0	92

Econometric Results:

Table-6 presents the estimation results. In general, the estimated parameters are significant and have the expected signs. The model is statistically valid with a likelihood ratio equal to 7671 (the chi-squared statistic is significant at 1%). Then, at least one explanatory variable has explanatory power on the outcome variable. The pseudo-R^2 is equal to 0,195. As expected, "distance" variable is statistically significant and inversely related to the source of drinking water (except for resellers where the effect is positive but not statistically significant). Thus, the longer the distance to a particular source of drinking water, the lower will be the demand for same. Nketiah-Amponsah et al. (2009) as well as Briand et al (2009) highlight the effects of the distance on the choice of water source. Our finding is also consistent with Hindman (2002) who found that time cost is an important determinant of household choice of drinking water source. Estimation results also show that female household heads tend to choose nearest solutions (private tap or collective tap). They are rather less likely to choose public drinking fountain/borehole and unimproved sources as compared to improved dug well. This outcome can be justified by the fact that water fetching is the primary responsibility of women and that is why they are more sensitive to time cost than their husband counterpart. Time saved by adopting piped water for drinking purpose can therefore be reallocated to others domestic activities such as cooking. A meaningful water supply strategy in the rural and urban areas must therefore involve more women than men. In this model, we also explore the effects of changes in household welfare. Our study shows that the per capita expenditure used as proxy for household welfare has a significant and negative impact on the probability to choose unimproved (marginal effect is equal to -0,10). Inversely, these two factors increase access to public water network (via these three options: private tap, collective tap or connected neighbor) and public drinking fountain/borehole, albeit association between residence and public drinking fountain/borehole is not significant. As urban households become better-off, they are much more likely to choose improved quality water. Welfare effect is highlight by Asante (2003); Nauges and Van Den Berg (2009); Nauges and Strand (2007)

Residence area is a strong determinant of household choice of water source. Urban households are 5.7; 2.1 and 40.4 percentage points more likely to have access to piped water in residence, collective tap and resellers respectively as compared to well. The study shows that living in semi or urban area reduces the probability to choose public drinking fountain/borehole and unimproved sources. We also find that some estimated marginal impacts for the education level of household head dummies are statistically significant. It is in line with previous findings which show that Education level of household affect household decision. As expected, households are less likely to choose unimproved sources as compared to well if household head is literate (marginal effect is equal to –0,107). In fact, the higher the level of education household is, the more he is sensitive to health implications of water consumed. Household education is a significant predictor for private and collective tap indicating a strong association between these variables. Household size has an impact on household decision (we observe that this impact is not very important). There is a statistically significant association between household size and private tap. Household size has a negative impact on the demand for collective tap and resellers services. The impact of household size on private tap demand has already been highlighted by Briand et al. (2009). Contrary to a priori expectation, Hindman (2002) finds that household size has a significant negative effect on household choice of piped or pumped water. Our findings may be explained by the fact that the more people are in a household, the higher are the family needs in water and the easier these needs can be satisfied by in-house tap compared to other outlying sources.

Table 6: Summary of the Econometric Results

Variables	Private tap	Collective type	Reseller of piped water	Public drinking water/tubewell	Unimproved sources
Sex(female=1)	0.0027 (.005)*	0.026 (0.007)*	0.00 (0.008)	-0.014 (0.007)**	-0.026 (0.011)**
Dist	-0.002	-0.031	0.003	-0.040	-0.036

	(0.001)***	(0.001)	(0.002)	(0.001)*	(0.002)
Hsize	0.013 (0.001)*	-0.004 (0.001)**	-0.005 (0.001)**	0.001 (0.001)	-0.005 (0.002)
Edu(literate=1)	0.026 (0.005)*	0.050 (0.007)*	0.013 (0.009)	-0.006 (0.008)	-0.107 (0.013)*
Lexp	0.090 (0.006)*	0.053 (0.006)*	0.022 (0.007)*	0.026 (0.006)*	-0.100 (0.009)*
Resid(urban=1)	0.057 (0.005)*	0.021 (0.005)*	0.404 (0.009)*	-0.011 (0.006)***	-0.419 (0.011)*
R-Square = 0.195 Likelihood Ratio Test: LR Chi-square (30) = 7671* Prob>chi-square =0.000 *significant at 1%, **significant at 5%, ***significant at 10%					

Conclusion:

Water is identified as one of the most important natural resources because it is viewed as a key to prosperity and wealth. Access to and use of safe drinking water can make an immense contribution to health, productivity, and social development. This study helps us to have a better understanding of the factors which influence the household choice of drinking water source. The study contributes to the still short literature on households' water choice of drinking water source using revealed preference approach. The multinomial logistic regression model has been used for discrete analysis of source choice. Data needs for empirical analysis are secondary data from a survey conducted in 2007 by the National Institute of Statistics. A cross-section of 11391 households was interviewed. In general, the estimated parameters are significant and have the expected signs. As expected, distance is statistically significant and inversely related to the source of drinking water (except for resellers where the effect is positive but not statistically significant). Thus, the longer the distance to a particular source of drinking water, the lower will be the demand for same. We believe that these results give policy-makers useful guidance in their attempt to provide sustainable water supply to the population. Consideration must be given to households time allocation patterns since they seems to be more concerned with the distance to the source than the type of water source (Hindman, 2002). People should be equipped with improved water sources as close as possible; otherwise, they will rely on nearest unimproved sources. Our study also suggests that female-headed households are more likely to adopt private tap or collective tap as main water source, compared with male-headed households. Moreover, household's size has a significant positive effect on household's choice of private tap and negative impact on household's choice of coping sources. Given that there is high demand for tap from households with high number of family members, Government should react by facilitating their access to private tap water. This may be done for instance, by giving priorities to this group of households, when implementing campaigns of State subsidies for connection to public network. The study also suggests that households' characteristics such as residence area and education have an impact on the choice of drinking water source. Especially, it has emerged from the study that the household expenditure (proxy of household welfare) is the fundamental factor which compels households to rely on unimproved sources. Thus, authorities should grant special attention to poorer households when implementing strategies for population access to safe and reliable water.

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